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Hidden Effects of Spring Wheat Productivity Management in the Conditions of Northern Kazakhstan

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ABSTRACT

The study was conducted in northern Kazakhstan at a precision farming test site in the Shortandinsky district of the Akmola region. It evaluated the effects of foliar treatments with the polymer fertilizer Vitanoll-NP and the humic preparation Stimulife on spring wheat yield, crop structure, and nutrient accumulation under drought conditions. Plant growth and development were assessed using ground-based observations and Earth remote sensing data obtained from Sentinel-2 imagery and unmanned aerial vehicles. The response of wheat plants varied depending on fertilizer type and application timing. Stimulife increased biological yield by 7.3–10.2%, whereas Vitanoll-NP produced increases of 12.1–18.0%, with the combined treatment showing the greatest effect. Foliar treatments also altered plant density, height, productive tillering, grain number per ear, and 1,000-grain weight. Chemical analysis indicated a tendency toward increased potassium accumulation in the grain, while nitrogen and phosphorus contents did not increase. The results revealed hidden effects of spring wheat productivity management associated with variation in the attraction effect, namely the redistribution of assimilates and mineral nutrients from vegetative organs to the ear. This variability should be considered when selecting foliar fertilization strategies for spring wheat under water-limited conditions.

Keywords: *Attraction effect, Earth remote sensing data, Foliar treatment, Northern Kazakhstan, Stimulife fertilizers, Vitanoll*

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INTRODUCTION

In the period of accelerating development of innovative technologies for wheat production in an arid climate, it is important not only to use modern technical and technological means of precision farming with new digitalization tools (Yakushev *et al*., 2015), but also new methodological approaches. A breakthrough study in the management of the yield of agrophytocenosis, including the cultivation of wheat, is the work of Dyakov and Dragavtsev (2000), who showed that yield increases are formed by the positive contributions of seven genetic-physiological systems (GFS).

1. GFS attractions (ATTR). It controls the "absorption" (attraction) of photosynthetic products and mineral nutrients (plastic substances) from the stem and leaves to the attraction center. For cereals - in an ear, for sunflower - in a basket, etc. That is, during attraction, plastic substances are “sucked out” by the attraction center from the vegetative organs into the reproductive and stock tissues.
2. GFS of microdistributions of attracted plastic substances (MIC) between grains and chaff in an ear of wheat, between the kernel of a seed and a husk in a sunflower, etc.
3. GPS adaptability (AD) can be the general adaptability of plants of a variety to the specific conditions of the field and the year of testing. And in case of formation provocative backgrounds, such as drought, cold, heat, salinity, changes in soil pH, etc. - HFS of specific adaptability will manifest itself.
4. GFS of horizontal immunity (IMM). It is determined by horizontal (polygenic) resistance to diseases and pests.
5. GFS "payment" by the dry biomass of the plant for the unit of the limiting factor of soil nutrition - N, P, K, etc. (EFF), i.e., the drier biomass a plant gives against a low background of any element of soil nutrition, the better the HFS EFF works.
6. GFS tolerance to thickening of agrocenosis. That is, the ability to increase the yield at a high sowing density and "keep" a large number of ears per 1 m^2 of its area. It is interesting to note the peculiarity of this effect in

multispecies agrophytocenoses and natural multicomponent phytocenoses, which ensure the integral stability of the community, the effects of synusia, and population rhythms.

7. GPS genetic variability in the duration of ontogenesis phases (ONT). Sometimes in breeding, for example, of winter wheat, it is necessary to shorten the filling phase in order to get away from the July heat, which leads to the fragility of the grains.

In general, maximizing the contributions to the harvest of all seven GFS is capable of raising yields by 60-80% (and sometimes by 100%). The spring wheat variety Grenada, zoned in 2019, created by selective improvement of 5 out of seven HFS, exceeded the yields of all standard varieties in the 9th (Ural) and 10th (West Siberian) regions, in which the area under spring wheat is 15 million hectares, by 10-12 c / ha. We have already received 1,000 tons of seeds from Grenada, which are snapped up by farmers and farms (30,000 rubles a ton each). The expected economic effect from the increase in the yield of the Grenada variety (in 2 years) is 60 billion rubles annually.

MATERIALS AND METHODS

The studies were carried out at the experimental site of the Shortandinsky district of the Akmola region, in the subzone of southern carbonate chernozems of heavy loamy texture in the conditions of 2019. The experimental site of the field was sown with varieties of spring wheat of different ripeness groups.

The experiments were carried out both in production conditions (plot of 1-10 hectares) using the technical means of the economy during all operations (sowing, processing, harvesting), and small-scale (plot of 10-100 m^2), where, mainly, a more thorough manual method. The growth and development of plants were assessed both by ground-based observations and by using data from Earth remote sensing - ERS (Busse *et al*., 2014; Banu, 2015). Satellite monitoring was carried out using the LandViewer service. The images were obtained both from satellites of the Sentinel 2 group and using unmanned aerial vehicles (UAVs).

The object of the research was the humic preparation "Stimulife", which was chosen among humic fertilizers as the most effective means of irregular polymer composition (Kurtener *et al*., 2014). A distinctive feature of this humic product consisted in the fact that to obtain it, the process of oxidative ammonolysis was used, which made it possible to "pump" more than 10% nitrogen into the polymer matrix, mainly into heterocycles. The drug "Stimulife" (TU 2186-016-79850210-2007) was produced at LLC "Agrofizprodukt" in the process of ammonolysis of peat in a solution of aqueous ammonia in the presence of hydrogen peroxide at the specified chemical and technological parameters. The drug is used both in pure form and enriched with nutrients and microelements.

Fertilizer of the Vitanoll series was used as another object of research (Komarov & Komarov, 2018). A distinctive feature of this fertilizer was that it was based on a polymer matrix of regular composition with the inclusion of nutrients. In this case, the fertilizer with nitrogen and phosphorus "Vitanoll-NP" was used (Komarov & Komarov, 2018).

The terms of treatment of plants with preparations were chosen in such a way that their greatest effectiveness was manifested. Thus, it was previously shown that the use of the drug "Stimulife" is most expedient during the period of "going into the tube" (when it promotes the activation of physiological processes of plant growth and development due to the hormonal effect of the auxin type) and in the phase of "grain formation", when the hormonal the effect of a different type (cytokinin, where due to the intensification of cell division, the attraction is enhanced (AgroServer.ru, n.d.; Kuban Agricultural Information and Consulting Center, n.d.).

Fertilizer "Vitanoll-NP" was used in the earliest phases of plant growth and development (seedlings, tillering phase) in order to activate the development of the root system of plants by providing plants with available phosphorus in the presence of nitrogen (Komarov & Komarov, 2018). Statistical processing of the experimental results was carried out using the Stat program. To assess the Earth remote sensing (ERS) data, the LandViewer service software package was used.

RESULTS AND DISCUSSION

When using one or another means of controlling the growth and development of plants (be it biological products, fertilizers, plant protection products, etc.), a prompt and reliable assessment of their response to the means used is important (Bavec & Bavec, 2001). **Figure 1** shows an assessment of the dynamics of changes in the NDVI vegetation index for the 2019 growing season at the site with a production experiment. The humic fertilizer "Stimulife" was tested on this site.

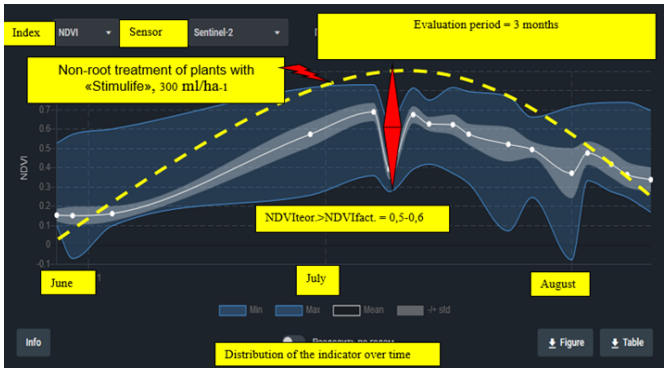

Figure 1. Features of the theoretical and practical dynamics of the vegetation index when using foliar feeding of plants with the drug "Stimulife"

Figure 1 shows the graph of plant development according to the NDVI index for field no. 35 for the period from May 26 to August 10, 2019. It is noted that the change in the vegetation index over time is not uniform. A gradual increase in the vegetation index from 0.12 to 0.7 (July 5-6) characterizes the growth of the vegetative mass and the activation of growth processes. At the same time, the vegetation index does not reach the expected values of 0.9-1.0, which characterizes the insufficient completeness of the physiological processes of the accumulation of plastic substances in the plant biomass. So, in the dissertation work (Singh & Ryan, 2015). Ionova N.E. (2011) showed that an increase in wheat productivity is determined by the potential that can be formed at the stage of plant phytomass accumulation in the flowering phase. At the same time, an increase in grain productivity for varieties with a large stem mass is due to photosynthetic activity, which is well identified using remote sensing data. However, under the conditions of the experiment, completely different data were obtained (Bukhary, 2024).

The dotted line in the figure denotes the predicted effect of an increase in plant biomass and, accordingly, the NDVI index. However, in fact, there is not an increase, but, on the contrary, a sharp decrease in the vegetation index (NDVItheor.> NDVIpract. By more than 0.6 units). This characterizes a significant decrease in active photosynthesis, a decrease in the growth of plant biomass, and, accordingly, a predicted decrease in yield (Belfiore *et al*., 2024; Figueroa-Valverde *et al*., 2024; Garbarova & Vartiak, 2024; Karatas, 2024; Negreiros & Ory, 2024; Pham, 2024; Wolderslund *et al*., 2024; Johar *et al*., 2025). The latter may be associated not only with arid conditions, high temperatures, and lack of moisture, which did not allow for realizing the potential of cultivated varieties and agro-technological solutions of precision farming. It is important to note that a sharp decrease in the NDVI index from 0.9 NDVI theoretical to 0.3 NDVI in practice is associated with the use of plant activation agents. However strange it may seem at first glance, in this case, due to the use of the drug "Stimulife", which was used as a foliar feeding at a dose of 300 ml/ha under the conditions of a production experiment (Ghiga *et al*., 2024; Kęska & Suchy, 2024; Kounatidis *et al*., 2024; Lee & Ferreira, 2024; Noor *et al*., 2024; Jagsi *et al*., 2025; Petronis *et al*., 2025; Wong *et al*., 2025; Yu *et al*., 2025).

It is known (Wang *et al*., 2020) that under drought conditions, the effectiveness of fertilizers, both as the main application and in the form of foliar dressing, is not fully realized. It is also known (Wang *et al*., 2001) that water evaporates in proportion to the leaf surface area, and the better the supply of nutrients to plants, the more intensive the growth of biomass, primarily of the leaf apparatus. When foliar treatment of plants with growth stimulants and fertilizers for the vegetative mass was realized in the experiment, there was an active growth of the leaf photosynthesizing and, accordingly, transpiring surface of the leaves. At the same time, an increase in the area of the sheet surface in the phase of exit into the tube by 50% leads to an increase in water consumption by 20 - 25%. After two to three weeks, the water consumption increases by 15-30 l /m^2, which leads to a loss of up to 5-8 c / ha of yield. Therefore, in this case, the activating effect of growth stimulants led to a negative effect, namely, a decrease in plant yield (Csep *et al*., 2024; Jin *et al*., 2024; Osluf *et al*., 2024; Rypel *et al*., 2024; Fischer *et al*., 2025; Kebe *et al*., 2025; Mansour & Saeed, 2025; Musa *et al*., 2025; Raza *et al*., 2025).

In addition to production experiments in the conditions of more detailed small-plot experiments, the effect of foliar treatment of wheat with the humic preparation "Stimulife" and "Vitanoll-NP" at different phases of growth processes was studied **(Table 1)**.

Table 1. Biological yield by variants of the experiment with foliar dressing, Field No. 3, 2019 (small-plot experiment).

Name of variant	Plant development phase/drug dose, l/ha^{-1}	Biological yield, t/ ha^{-1}	Increase	
			t/ ha^{-1}	%
Control	-	2,06		
"Stimulife"	outlet into the tube - 0,3 l/ha^{-1}	2,21	0,15	7,3
	grain formation – 0,3 l/ha^{-1}	2,21	0,15	7,3
	outlet into the tube - 0,3 l/ha^{-1} + grain formation – 0,3 l/ha^{-1}	2,27	0,21	10,2
"Vitanoll -NP"	seedlings – 0,3 l/ha^{-1}	2,31*	0,25*	12,1
	tillering of cereals - 1,0 l/ha^{-1}	2,33*	0,27*	13,1
	seedlings – 1,0 л/га + tillering - 1,0 l/ha^{-1}	2,43**	0,37**	18,0
	Experimental accuracy:			
	*least significant difference, LSD $_{05}$	0,22		
	** least significant difference, LSD $_{01}$	0,30		

It was found that during non-root treatment of plants with humic preparation "Stimulife", the biological yield slightly increased by 0,15- 0,21 t /ha^{-1} or by 7.3-10.2% **(Table 1)**. At the same time, the processing of plants in different phases of growth processes (exit to the tube and grain formation) had the same type of efficiency (0,15 t / ha^{-1} and 7.3%). However, due to combined processing (output to the tube+grain formation), there was a slight increase in yield (up to 0,21 t/ha^{-1} or 10.2%). When processing plants with polymer fertilizer "Vitanoll-NP", more significant crop increases were obtained, by 0,25-0,37 t/ha^{-1} or by 12.1-18%. That is, the inclusion of nitrogen and phosphorus in the polymer matrix provided an additional attraction effect. Dispersion analysis of the experiment results showed statistical significance for all treatments with the drug "Vitanoll-NP", and in some cases (for complex treatment of plants) even at the 1% significance level.

The specificity of the physiological action of "Stimulife" is shown when evaluating the structure of the crop **(Table 2)**. Thus, the treatment of wheat with a humic preparation "Stimulife" contributed to an increase in productive bushiness, but the density of standing plants during treatment with the preparation decreased. Moreover, the effect of reduction was more significantly manifested at the early stages of plant processing (in the phase of entering the tube, the density of standing plants was 127.3 number of plants/m^2, and in the phase of grain formation, 137.3 number of plants/m^2).

Moreover, the height of plants when processing plants with Stimulife decreased by 10-20%.

Table 2. Effect of foliar fertilization with the studied preparations on the structure of the wheat crop

Name of variant	Plant development phase/ drug dose, l/ha^{-1}	Crop structure					
		Plant standing density, number of plants/m^2	Plant height, cm	Productive bushiness, ears per 1 plant	The weight of the sheaf, g	Number of grains per ear, PCs.	Weight of 1000 grains, g.
Control	-	142,0	70,5	1,2	218,3	31,7	36,7
"Stimulife"	outlet into the tube - 0,3 l/ha^{-1}	127,3	58,1**	1,3*	226,7	34,7	37,2
	grain formation – 0,3 l/ha^{-1}	137,3	63,0**	1,3*	161,3**	33,7	36,3
	outlet into the tube - 0,3 l/ha^{-1} + grain formation – 0,3 l/ha^{-1}	136,0	64,8*	1,4**	172,0*	31,7	36,5
"Vitanoll - NP"	seedlings – 0,3 l/ha^{-1}	156,0	65,1*	1,3*	210,0	28,7	40,8
	tillering of cereals - 1,0 l/ha^{-1}	156,7	70,5	1,2	208,3	31,7	38,0
	seedlings – 1,0 л/га + tillering - 1,0 l/ha^{-1}	148,7	64,2*	1,3*	196,7	32,7	37,8
Experimental accuracy: *least significant difference, LSD $_{05}$ ** least significant difference, LSD $_{01}$		27,3 37,9	5,2 7,2	0,1 0,2	39,7 55,1	4,6 6,4	4,5 6,4

According to the data obtained, the biomass of plants would have to decrease, and, consequently, the plastic substances used for their formation could be used for the formation of grain. The total weight of the sheaf of experience variants to some extent characterizes this effect. Thus, the processing of plants in the phase of grain formation contributed to a decrease in the sheaf mass by more than 25%, while the processing of plants in the earlier phases of growth processes (exit to the tube), on the contrary, showed a tendency to increase the sheaf mass.

Another argument in favor of the effect of redistribution of flows of biophilic elements in the treatment of plants with humic preparation is the increase in the number of grains in the ear. Thus, the number of grains in the ear in the phase of grain formation increased to 33.7 PCs, or 6%, and in the early processing of plants in the phase of entering the tube to 34.7 PCs, or 10%. The mass of 1000 grains during the processing of plants in the exit phase of the tube increased to 37.2 g against 36.7 g at the control.

When using the "Vitanoll-NP" fertilizer, a slightly different effect was observed. Thus, the density of standing plants increased slightly (by about 10%), and the height of plants decreased only when using plant processing during their germination, while processing in the tillering phase equalized the height of plants relative to the control. Moreover, the effect of early processing was "fixed" with the complex application of treatments. The weight of the sheaf in all cases of treatment of plants with "Vitanoll - NP" fertilizer was less than in the control, which indicates the redistribution of biophilic elements due to the attraction effect. The significance of this conclusion is confirmed by the improvement of grain quality. At the same time, the number of grains in the ear increased slightly over the periods of plant development (shoots – 28.7 PCs., tillering-31.7 PCs., and with complex processing "shoots+tillering", even up to 32.7 PCs.). The reverse effect was observed for the mass of 1000 grains, where the highest indicators were recorded during early processing of plants (the mass of 1000 grains was 40.5 g, which is 10% higher than in the control). The data obtained are consistent with studies (Wang *et al*., 2001) demonstrating the photosynthetic characteristics of winter wheat varieties that differ by ear type and showing their relationship with the grain weight in the ear. Correlation studies of wheat yield and yield characteristics are demonstrated in (Kumar & Verma, 2000).

Evaluation of the chemical analysis of grain depending on the type of foliar feeding and the phase of application of the drug showed **(Table 3)**, that the use of both " Stimulife "and" Vitanoll " led to the accumulation of only potassium in the grain, while the content of nitrogen and phosphorus when using the drug tended to decrease.

Table 3. Main indicators of chemical analysis of grain depending on the type of foliar feeding and the phase of application of the drug. Field No. 3, 2019.

Name of variant	Plant development phase/drug dose, l/ha^{-1}	Protein, %	Nitrogen,%	Phosphorus,%	Potassium,%
		15,38	2,70	0,46	0,48
Control "Stimulife"	-	15,02	2,63	0,43	0,51
	outlet into the tube - 0,3 l/ha^{-1}	15,21	2,66	0,44	0,46
	grain formation – 0,3 l/ha^{-1}	14,78	2,59	0,45	0,49
"Vitanoll –NP"	outlet into the tube - 0,3 l/ha^{-1} + grain formation – 0,3 l/ha^{-1}	14,66	2,57	0,44	0,50
	seedlings – 0,3 l/ha^{-1}	14,99	2,62	0,46	0,50
	tillering of cereals - 1,0 l/ha^{-1}	14,90	2,61	0,44	0,50
	seedlings – 1,0 л/га + tillering - 1,0 l/ha^{-1}				

Probably, to enhance the effect of the action, it was necessary to regulate not only stimulating drugs, but also inhibitors, since it is during attraction that competition for plastic substances occurs between the ear and the leaves. Because, as it was shown earlier (Inoue *et al*., 2004a; Yakushev *et al*., 2015), healthy leaves prevent the outflow of assimilates into the ear, thereby limiting the effect of attraction. The data presented by us are consistent with the research results obtained when studying the effect of drought on the photosynthesis of wheat varieties that are characterized by drought resistance (Inoue *et al*., 2004b). The contribution of current photosynthesis assimilates to grain yield, and their relationship to drought resistance in wheat varieties grown at different soil humidities was also evaluated. In our research, as well as in the experiments conducted in the Astrakhan region (Tumanyan *et al.,* 2020), it is shown that the controlling, effective agrotechnological technique for increasing the yield of spring wheat is timely foliar fertilization of plants carried out during certain phases of plant growth and development. At the same time, when managing the productivity of spring wheat in the conditions of drought in Northern Kazakhstan, it is necessary to take into account the effects of the ear attraction.

CONCLUSION

As a result of field studies conducted in the arid climate of Northern Kazakhstan, a positive effect of non-root fertilization of wheat plants with humic preparation "Stimulife" and polymer fertilizer "Vitanoll-NP" was shown.

The attraction effect observed in the experiment, which consists of the redistribution of photosynthetic products and mineral nutrition elements from the stem and leaves to the attraction centers, was more informative when analyzing the structure of the crop, rather than due to a more labor-intensive and expensive chemical analysis of the grain.

Thus, in a simple field experiment, the work of the first ATTR system of seven genetic and physiological systems (GFS), discovered and described by the scientific school of V. A. Dragavtsev, was demonstrated.

Only based on an assessment of the reduction in the effect of attraction can we explain the lack of stimulating action of most drugs and fertilizers, which are very effective in other regions. Therefore, it is very effective in the Northern latitudes to stimulate the development of the leaf surface of plants, which serves to eliminate the limiting factor of photosynthesis; in the southern latitudes is not effective and is even contraindicated. This reaction of the GFS attraction should be taken into account when managing plant productivity in the conditions of drought in Northern Kazakhstan, as well as in other countries with arid climates.

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REFERENCES

AgroServer.ru. (n.d.). *STIMULIFE is an organomineral fertilizer containing humic and fulic acids*. https://agroserver.ru/b/stimulayf-organomineralnoe-udobrenie-s-soderzhaniem-guminovy-350517.htm

Banu, S. (2015). Precision agriculture: Tomorrow's technology for today's farmer. *Journal of Food Processing & Technology, 6*, 1000468. doi:10.4172/2157-7110.1000468

Bavec, F., & Bavec, M. (2001). Chlorophyll meter readings of winter wheat cultivars and grain prediction. *Communications in Soil Science and Plant Analysis, 32*, 2709–2719. doi:10.1081/CSS-120000956

Busse, M., Doernberg, A., Siebert, R., Kuntosch, A., Schwerdtner, W., König, B., & Bokelmann, W. (2014). Innovation mechanisms in German precision farming. *Precision Agriculture, 15*, 403–426. doi:10.1007/s11119-013-9337-2

Csep, A. N., Voiţă-Mekereş, F., Tudoran, C., & Manole, F. (2024). Understanding and managing polypharmacy in the aging population. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 17–23. doi:10.51847/VdKr0egSln

Dyakov, A. B., & Dragavtsev, V. A. (2000). Multidirectional shifts in the quantitative characteristic of an individual organism under the influence of genetic and environmental causes in two-dimensional systems of characteristic coordinates. In V. A. Dragavtsev (Ed.), *Algorithms for ecological and genetic inventory of the gene pool and methods for designing varieties of agricultural plants by yield, stability and quality* (pp. 22–47). VIR.

Fischer, D., Meier, L., Braun, T., Koch, S., & Roth, F. (2025). Predicting controlled-release tablet dissolution using polymer grade, drug solubility, and compression parameters. *Pharmacophore, 16*(1), 1–10. doi:10.51847/CDuGR6SWTD

Ghiga, I., Pitchforth, E., Lundborg, C. S., & Machowska, A. (2024). Bacterial infections and antibiotic resistance in Romanian children: Insights from a hospital-based study. *Interdisciplinary Research in Medical Sciences Special, 4*(2), 1–8. doi:10.51847/pISlxaQJVu

Inoue, T., Inanaga, S., Sugimoto, Y., & El Siddig, K. (2004b). Contribution of pre-anthesis assimilates and current photosynthesis to grain yield, and their relationships to drop resistance in wheat cultivars grown under different soil moisture. *Photosynthetica, 42*, 99–104. doi:10.1023/B:PHOT.0000040576.52128.ed

Inoue, T., Inanaga, S., Sugimoto, Y., An, P., & Eneji, A. E. (2004a). Effect of drought on ear and flag leaf photosynthesis of two wheat cultivars differing in drought resistance. *Photosynthetica, 42*, 559–565. doi:10.1007/S11099-005-0013-2

Ionova, E. V. (2011). *Resistance of wheat, barley, and sorghum varieties and lines to regional types of drought* [Doctoral dissertation, All-Russian Research Institute of Rice].

Jagsi, R., Lee, J., Roselin, D., Ira, K., & Williams, J. (2025). Do U.S. medical schools follow medical associations' recommendations on paid parental leave for faculty? *Annals of Pharmacy Education, Safety, and Public Health Advocacy, 5*, 1–11. doi:10.51847/r117In8wdi

Jin, L. W., Tahir, N. A. M., Islahudin, F., & Chuen, L. S. (2024). Exploring treatment adherence and quality of life among patients with transfusion-dependent thalassemia. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 8–16. doi:10.51847/B8R85qakUv

Kebe, I. A., Kahl, C., & Liu, Y. (2025). The role of transformational leadership in enhancing employee performance: A study of the Vietnamese banking industry. *Annals of Organizational Culture, Leadership and External Engagement Journal, 6*, 21–30. doi:10.51847/g7jtt7Qgxk

Komarov, A. A., & Komarov, A. A. (2018). Prospects of the use of complex agrochemicals for differentiated its introduction as a means of growth management and plant development. *Agrochemistry Herald, 6*, 34–38. doi:10.24411/0235-2516-2018-10057

Kounatidis, D., Dalamaga, M., Grivakou, E., Karampela, I., Koufopoulos, P., Dalopoulos, V., Adamidis, N., Mylona, E., Kaziani, A., & Vallianou, N. G. (2024). Evaluation of blood-aqueous barrier permeability in response to tetracycline antibiotics under normal and pathological conditions. *Interdisciplinary Research in Medical Sciences Special, 4*(2), 9–17. doi:10.51847/wu4fOEjgDv

Kuban Agricultural Information and Consulting Center. (n.d.). *STIMULIFE liquid organomineral fertilizer containing humic and fulic acids*. http://www.kaicc.ru/node/1207

Kumar, A., & Verma, R. S. (2000). Correlation studies of yield and yield attributes of wheat (*Triticum aestivum*). *Gujarat Agricultural University Research Journal, 25*, 5–8.

Kurtener, D. A., Komarov, A. A., Krueger, E. D., Lavrukov, M. Yu., & Nayda, N. M. (2014). Fuzzy multi-attributive analysis of organic-mineral fertilizer "Stimulayf" and "Humate Sodium" application for cultivation of *Dracocephalum* L. *European Agrophysical Journal, 1*, 14–24.

Mansour, A., & Saeed, O. (2025). SHAP-guided graph neural networks for hepatotoxicity prediction using molecular substructures and cytotoxicity profiles. *Pharmacophore, 16*(1), 21–30. doi:10.51847/tFWErcXy9u

Musa, K., Noor, O., Ibrahim, M., & Saleh, A. (2025). A validated whole-body PBPK model of dextromethorphan and its metabolites for genotype-based prediction of CYP2D6 phenotype and urinary metabolic ratio. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 5*, 50–76. doi:10.51847/xbESBJHHcx

Osluf, A. S. H., Shoukeer, M., & Almarzoog, N. A. (2024). Case report on persistent fetal vasculature accompanied by congenital hydrocephalus. *Asian Journal of Current Research in Clinical Cancer, 4*(1), 25–30. doi:10.51847/0gjOEudJNr

Petronis, Z., Golubevas, R., Rokicki, J. P., Guzeviciene, V., Sakavicius, D., & Lukosiunas, A. (2025). A systematic review and meta-analysis on trigeminal neuralgia linked to neurovascular compression using MRI analysis. *Journal of Current Research in Oral Surgery, 5*, 17–24. doi:10.51847/sptZWIrWeo

Raza, S., Khan, A., Mehmood, F., & Farooq, U. (2025). Nationwide implementation of essential pharmacogenomic testing in the Netherlands: A decision-analytic model of lives saved and cost-effectiveness. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 5*, 39–49. doi:10.51847/PUWEymkYkk

Rypel, J., Kubacka, P., Mykała-Cieśla, J., Pająk, J., Bulska-Będkowska, W., & Chudek, J. (2024). Case presentation of breast adenoid cystic carcinoma. *Asian Journal of Current Research in Clinical Cancer, 4*(1), 18–24. doi:10.51847/6eOqq2KFjp

Singh, B., & Ryan, J. (2015). *Managing fertilizers to enhance soil* (1st ed.). International Fertilizer Industry Association. doi:10.13140/RG.2.1.2806.5448

Tumanyan, A. F., Tyutyuma, N. V., & Bondarenko, A. N. (2020). Cultural practices for maximizing yield of winter and spring cereals in the Astrakhan Region. *Theoretical and Applied Problems of Agro-Industrial Complex, 1*, 3–6. doi:10.32935/2221-7312-2020-43-1-3-6

Wang, Y., Huang, Y., Fu, W., Guo, W., Ren, N., Zhao, Y., & Ye, Y. (2020). Efficient physiological and nutrient use efficiency responses of maize leaves to drought stress under different field nitrogen conditions. *Agronomy, 10*, 523. doi:10.3390/agronomy10040523

Wang, Z.-M., Wei, A.-L., & Zheng, D.-M. (2001). Photosynthetic characteristics of non-leaf organs of winter wheat cultivars differing in ear type and their relationship with grain mass per ear. *Photosynthetica, 39*, 239–244. doi:10.1023/A:1013743523029

Yakushev, V. P., Mikhailenko, I. M., & Dragavtsev, V. A. (2015). Reserves of agro-technologies and breeding for increasing cereal yield in the Russian Federation. *Agricultural Biology, 50*, 550–560. doi:10.15389/agrobiology.2015.5.550rus

Yu, M., Ma, Y., Han, F., & Gao, X. (2025). Effectiveness of mandibular advancement splint in treating obstructive sleep apnea: A systematic review. *Journal of Current Research in Oral Surgery, 5*, 25–32. doi:10.51847/AInSXrD9rc