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Augmentation of the growth and seed yield of summer groundnut (*Arachis hypogaea* L.) with micronutrients

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Abstract
The field experiments were conducted in the two successive *summer* seasons of 2020 and 2021 at All India Coordinated Research Project on Summer Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri to investigate the response of groundnut varieties SB-XI and *Phule* Unnati with micronutrients application *viz.*, soil application of *Phule* Micro grade I @ 25 kg ha^{-1} at the time of sowing and foliar application *Phule* Liquid Micro grade II @ 1.0% at 35 and 45 days after sowing and their interaction to augment the growth and yield of summer groundnut. The experiments were designed in factorial completely randomized block design with four replications. Results indicated that the application of micronutrients and their interaction with groundnut varieties had a significant impact on the growth and yield attributes of summer groundnut. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing significantly demonstrated the maximum number of branches^{-1}, number of pods plant^{-1}, pod yield, 100 pod weight, kernel yield, 100 kernel weight, shelling outturn and sound mature kernel of summer groundnut. Therefore, the application of micronutrients through foliar spray may be included in the package of practices for cultivation of summer groundnut in order to increase the crop's potential for growth and seed yield.

Keywords: Summer groundnut, micronutrients, pod yield, kernel yield, shelling outturn, SMK

Introduction
Micronutrients play a vital role in growth, yield and production though it required by plants in relatively smaller quantity, also referred as trace elements, oligo elements or spurn elements. Intensification of agriculture, usage of straight fertilizers rising crop requirements due to increasing productivity levels have heightened the micronutrients demand in soil fertility management and are becoming major constraints to achieve agricultural production. Therefore, in order to increase production of groundnut with high yield and quality, an adequate fertilization of micronutrients should be implemented (Prusty *et al*., 2020) [14].

Among the micronutrients, iron and boron are involved in the kernel filling and hence are required in higher quantity. Iron chlorosis in groundnut is the major concern in many calcareous soils. The acute deficiency of iron leads to dying of plants in the field and crop failure and ultimately causes 16-40% yield losses (Singh *et al.*, 2004) [24]. The micronutrient most often limiting for groundnut production is boron and it plays a key role in kernel quality. Boron is highly essential for proper seed setting and improvement in seed quality of groundnut (Meena *et al.*, 2007) [9]. Boron deficiency results in 'hollow-heart' in groundnut kernel. It is evident that application of boron enhanced the seed yield in groundnut (Nandi *et al.*, 2020) [10]. Boron and molybdenum has the ability to improve yield and yield parameters of groundnut (Nasar *et al.*, 2018) [11]. Molybdenum is also essential for nitrogen fixation and involved in several enzyme systems. It increases dry matter production and improves nodulation in groundnut (Sharma *et al*., 2017) [21]. The 13-19% yield losses are reported due to molybdenum deficiency (Singh, 2001) [23]. Manganese imparts oxidation reduction process, photosynthesis, oxygen evolution and involved in many biological processes. Chlorine alongwith manganese is required for oxygen evolution and photosynthesis (Singh *et al.*, 2004) [24]. Manganese acts as an activator for many enzymes (Sabra *et al.*, 2019) [17]. Majority of groundnut is grown on calcareous soil where manganese deficiency is bound to occur causing 8-17% yield losses (Singh, 2001) [23]. Zinc deficiency is the most detrimental to crop yield (Senthilkumar, 2018) [20]. It plays as an activator of several enzymes in plants and involved in biosynthesis of growth substances. The application of zinc increases nodulation, chlorophyll content and pod yield

and thus increases the seed yield of groundnut (Kader and Mona, 2013) [8]. But the yield losses due to zinc deficiency reported 15-20%. Copper is rarely applied to the groundnut crop but its application increases the pod yield significantly (Singh, 2001) [23].

Thus, one of the major constraints for low yield of groundnut relates to the deficiency of micronutrients. Whenever, the supply of one or more of these micronutrients is insufficient, yields will be reduced significantly. Therefore, the optimization of the micronutrients is the key way to optimize the production of groundnut. Furthermore, the improvement in productivity is due to the application of micronutrients might have supported to escalate the pod yield and pod weight. Consequently, the micronutrients fertilization is essential for enhancing the productivity of groundnut crop. Therefore, the field experimentations were carried out for augmentation of the summer groundnut (*Arachis hypogaea* L.) with micronutrients application.

Materials and Methods

The seeds of SB-XI and *Phule Unnati* varieties were obtained from AICRP on Summer Groundnut and the micronutrients *viz.*, *Phule* Micro grade I and *Phule* Liquid Micro grade II were obtained from Micronutrient Research Project, MPKV, Rahuri. The experimental layout was prepared with 24 plots having gross size of 5.00 m × 1.80 m with six rows in each plot. The seeds of groundnut were sown at spacing 30 × 10 cm with 50 dibbles row^{-1}. The micronutrients *viz.*, *Phule* Micro grade I (M_1) and *Phule* liquid Micro grade II (M_2) were applied @ 25 kg ha^{-1} at the time of sowing and 1.0% at 35 and 45 days after sowing, respectively.

Micronutrients application

M_0: Control (Recommended RDF)

M_1: Recommended RDF + *Phule* Micro grade I @ 25 kg ha^{-1} at the time of sowing

(Zn 5.0%, Fe 2.0%, B 1.0%, Cu 0.5% & Mn 1.0%)

M_2: Recommended RDF + *Phule* Liquid Micro grade II @ 1.0% at 35 and 45 days after sowing

(Zn 3.0%, Fe 2.5%, B 0.5% Cu 1.0%, Mn 1.0% & Mo 0.1%)

The observations on growth and yield attributes were recorded at harvest.

Observations recorded

Number of branches plant^{-1}

At harvest, five plants were selected randomly from the net area of each plot and were tagged. The branches of each plant were counted and the mean was expressed in numbers.

Number of pods plant^{-1}

The pods harvested from the earlier tagged five plants in each plot were counted and the mean was expressed in number.

Pod yield

The pods from the net area of each plot were harvested and dried separately to record the pod yield. The pod weight plot^{-1} was taken and the data was converted into pod yield in q ha^{-1}.

100 pods weight

The pods harvested from earlier tagged five plants in each plot were cleaned and dried separately. The weight of 100 pods was taken and expressed as 100 pod weight in grams.

Kernel yield

The dried pods harvested from net area of each plot were shelled manually to record kernel yield. The kernel weight plot^{-1} was taken and the data was converted into kernel yield in q ha^{-1}.

100 kernels weight

The dried pods harvested from tagged five plants in each plot were shelled manually. The weight of 100 kernels was calculated and expressed as 100 kernel weight in grams.

Shelling outturn

One hundred grams of dried and cleaned pods from each plot were shelled manually. The weight of the kernels was recorded and expressed as shelling outturn in percentage by employing the following formulae.

$$\text{Shelling outturn (\%)} = \frac{\text{Weight of kernels (g)}}{\text{Weight of pods (g)}} \times 100$$

Sound mature kernel (SMK)

One hundred grams of dried and cleaned pods from each plot were shelled manually. Well-developed kernels were sorted and the sound mature kernel was calculated by employing the following formulae.

$$\text{SMK (\%)} = \frac{\text{Number of well-developed kernels}}{\text{Weight of pods (g)}} \times 100$$

Statistical analysis

The data collected from field experiments on all attributes were analyzed by adopting factorial randomized block design (FRBD) statistical methods described by Panse and Sukhatme (1985) [13]. The critical differences (CD) for field experiments were calculated at five per cent probability level wherever 'F' test found significant for growth and yield attributes.

Results and Discussion

The data regarding growth and yield attributes *viz.*, number of branches plant^{-1} number of pods plant^{-1}, pod yield, 100 pods weight, kernel yield, 100 kernels weight, shelling outturn and sound mature kernels as influenced by groundnut varieties, micronutrients application and their interactions are summarized in Table 1 and graphically illustrated in Figure 1, 2, 3 and 4.

Number of branches plant^{-1}

The maximum number of branches plant^{-1} (11.08) observed in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (6.93), on pooled basis. Nevertheless, the foliar application of *Phule* liquid Micro grade II (M_2) recorded the maximum number of branches plant^{-1} (10.46) as compared to soil application of *Phule* Micro grade I (M_1) (8.59) and Control (M_0) and (7.96) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) exhibited the maximum

number of branches plant^{-1} (12.53) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (10.86) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (6.06) exhibited minimum number of branches plant^{-1} on pooled basis.

The interaction effect of the groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II exhibited the maximum number of branches plant^{-1}. These results are in agreement with the Nasar *et al.* (2018) [11] who observed that the foliar application of micronutrients *viz.*, boron and molybdenum favoured good growth and found improved all physiological parameters of groundnut. Sharma *et al*., (2017) [21] noticed that the application of micronutrients was associated with the highest number of branches plant^{-1} of summer groundnut. Similar results were found by Reddy *et al*. (2020) [16] and Noaman *et al*. (2022) [12].

Number of pods plant^{-1}

The maximum number of pods plant^{-1} (38.01) obtained in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (25.53) on pooled basis. Nevertheless, the foliar application of *Phule* liquid Micro grade II (M_2) reported the maximum number of pods plant^{-1} (36.47) as compared to soil application of *Phule* Micro grade I (M_1) (31.09) and Control (M_0) (27.75) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) found the maximum number of pods plant^{-1} (43.11) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (37.02) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (21.60) found minimum number of pods plant^{-1} on pooled basis.

Table 1: Effect of groundnut varieties, micronutrients application and their interaction on growth and yield parameters of summer groundnut

Treatment	No. of branches plant^{-1}			No. of pods plant^{-1}			Pod yield (q ha^{-1})			100 pod weight (g)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Variety (V)												
V_1	6.65	7.21	6.93	25.22	25.84	25.53	17.44	15.70	16.57	47.08	45.00	46.04
V_2	10.81	11.36	11.08	41.13	34.89	38.01	30.21	26.39	28.30	61.33	58.08	59.71
SEm (±)	0.052	0.035	0.063	0.014	0.036	0.039	0.007	0.007	0.009	0.109	0.248	0.271
CD @ 5%	0.157	0.104	0.181	0.043	0.109	0.113	0.020	0.020	0.027	0.328	0.747	0.782
Micronutrient (M)												
M_0	7.40	8.53	7.96	28.47	27.03	27.75	20.96	19.42	20.19	52.88	49.38	51.13
M_1	8.56	8.63	8.59	32.57	29.60	31.09	24.18	20.77	22.47	53.38	51.88	52.63
M_2	10.23	10.70	10.46	38.48	34.46	36.47	26.34	22.94	24.64	56.38	53.38	54.88
SEm (±)	0.023	0.015	0.038	0.006	0.016	0.024	0.003	0.003	0.006	0.047	0.107	0.166
CD @ 5%	0.068	0.045	0.111	0.019	0.047	0.069	0.009	0.009	0.017	0.142	0.324	0.479
Variety × Micronutrient (V × M)												
V_1M_0	6.05	6.08	6.06	20.56	22.65	21.60	14.67	13.93	14.30	47.25	45.00	46.13
V_1M_1	6.45	6.20	6.33	24.59	25.73	25.16	17.93	15.32	16.62	46.50	44.25	45.38
V_1M_2	7.45	9.35	8.40	30.50	29.15	29.82	19.74	17.84	18.79	47.50	45.75	46.63
V_2M_0	8.75	10.98	9.86	36.38	31.40	33.89	27.26	24.91	26.09	58.50	53.75	56.13
V_2M_1	10.68	11.05	10.86	40.55	33.48	37.02	30.43	26.22	28.32	60.25	59.50	59.88
V_2M_2	13.00	12.05	12.53	46.45	39.78	43.11	32.94	28.04	30.49	65.25	61.00	63.13
SEm (±)	0.090	0.060	0.108	0.025	0.063	0.068	0.012	0.011	0.016	0.189	0.429	0.469
CD @ 5%	0.272	0.180	0.313	0.075	0.189	0.195	0.035	0.035	0.047	0.568	1.294	1.354
General Mean	8.73	9.28	9.01	33.17	30.36	31.77	23.83	21.04	22.43	54.21	51.54	52.88
CV (%)	2.07	1.29	1.70	0.15	0.41	0.30	0.10	0.11	0.10	0.70	1.67	1.25
Variety (V)												
V_1	12.44	10.54	11.49	33.50	30.42	31.96	71.48	67.12	69.30	92.17	90.50	91.33
V_2	20.42	17.13	18.77	40.75	39.00	39.88	67.53	64.84	66.18	93.08	91.75	92.42
SEm (±)	0.010	0.012	0.015	0.065	0.048	0.080	0.036	0.033	0.049	0.060	0.064	0.088
CD @ 5%	0.030	0.036	0.044	0.195	0.145	0.232	0.110	0.099	0.142	0.180	0.193	0.253
Micronutrient (M)												
M_0	14.18	12.50	13.34	36.25	33.50	34.88	68.05	64.55	66.30	91.12	90.13	90.63
M_1	16.57	13.55	15.06	36.88	35.13	36.00	69.03	65.75	67.39	92.87	91.25	92.06
M_2	18.53	15.45	16.99	38.25	35.50	36.88	71.43	67.64	69.53	93.88	92.00	92.94
SEm (±)	0.004	0.005	0.009	0.028	0.021	0.049	0.016	0.014	0.030	0.026	0.028	0.054
CD @ 5%	0.013	0.015	0.027	0.084	0.063	0.142	0.047	0.043	0.087	0.078	0.083	0.155
Variety × Micronutrient (V × M)												
V_1M_0	10.16	9.04	9.60	32.75	29.25	31.00	69.30	65.09	67.20	90.25	89.25	89.75
V_1M_1	12.72	10.29	11.51	33.00	30.50	31.75	70.98	67.37	69.17	92.75	91.00	91.87
V_1M_2	14.44	12.29	13.36	34.75	31.50	33.13	74.15	68.89	71.52	93.50	91.25	92.37
V_2M_0	18.20	15.95	17.07	39.75	37.75	38.75	66.79	64.01	65.40	92.00	91.00	91.50
V_2M_1	20.43	16.81	18.62	40.75	39.75	40.25	67.07	64.13	65.60	93.00	91.50	92.25
V_2M_2	22.63	18.62	20.63	41.75	39.50	40.63	68.71	66.38	67.55	94.25	92.75	93.50
SEm (±)	0.017	0.021	0.027	0.112	0.083	0.139	0.063	0.057	0.085	0.104	0.111	0.152
CD @ 5%	0.051	0.062	0.077	0.337	0.251	0.403	0.190	0.172	0.245	90.25	89.25	89.75
General Mean	16.43	13.83	15.13	37.13	34.71	35.92	69.50	65.98	67.74	92.62	91.13	91.88
CV (%)	0.21	0.30	0.25	0.60	0.48	0.55	0.18	0.17	0.18	0.22	0.24	0.23

NS – Non significant **DAS** – Days after storage

V_1 – SB-XI V_2 – *Phule Unnati* M_0 – Control

M_1 – Soil application of *Phule* Micro grade I @ 25 kg ha^{-1} at the time of sowing

M_2 – Foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing

The interaction between *Phule Unnati*, a groundnut variety and *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing application foliarly recorded the maximum number of pods plant^{-1}**.** The observations of the current investigation are congruent with those drawn by Nasar *et al.* (2018) [11] who said that although micronutrients may be supplied to plants in two different ways *i.e.* soil and foliar, foliar application was the most effective method. Further it has been observed that the boron and molybdenum were required micronutrients for good growth and found improved all physiological parameters of groundnut. Sharma *et al*., (2017) [21] noticed that the application of micronutrients was associated with the highest number of branches plant^{-1} of summer groundnut. Sabra *et al*. (2019) [17] seen the influence of micronutrients namely zinc, manganese and boron applied by foliar spray on the groundnut and observed that the number of pods plant^{-1} was recorded the highest values. The findings of Shwetha *et al.* (2018) [22] and Satpute *et al.* (2021) [19] support these results.

Pod yield

The highest pod yield (28.30 q ha^{-1}) recorded in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (16.57 q ha^{-1}) on pooled basis. However, the foliar application of *Phule* liquid Micro grade II (M_2) found the highest pod yield (24.64 q ha^{-1}) as compared to soil application of *Phule* Micro grade I (M_1) (22.47 q ha^{-1}) and Control (M_0) (20.19 q ha^{-1}) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) reported the highest pod yield (30.49 q ha^{-1}) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (28.32 q ha^{-1}) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (14.30 q ha^{-1}) reported lowest pod yield on pooled basis.

The interaction impact of the groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing observed the highest pod yield ha^{-1}**.** The application of micronutrients may be made more efficiently since the foliar spray allows plants to absorb the applied nutrients from the solution through their leaf surface (Helmy and Shaban, 2008) [7]. The same facts were also reported by Nasar *et al.* (2018) [11]. Senthilkumar (2018) [20] was in opinioned that the increased pods yield was recorded due to foliar application of Fe and Zn and concluded the application of micronutrient through foliar spray increased the crop yield. These results are further supported by the findings of Der *et al*. (2015) [4] who showed that the foliar application K @ 0.5% + Fe @ 0.5% + Zn @ 0.5% + B @ 0.2% at 40 days after sowing found maximum pod yield of groundnut. Similar findings was also reported by Abdel-Motagally *et al.* (2016) [1], Sharma *et al*., (2017) [21], Rajitha et al. (2018) [15], Sabra *et al*. (2019) [17] and Noaman *et al*. (2022) [12].

100 pod weight

The higher 100 pod weight (59.71 g) observed in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (46.04 g) on pooled basis. However, the foliar application of *Phule* liquid Micro grade II (M_2) recorded the higher 100 pod weight (54.88 g) as compared to soil application of *Phule* Micro grade I (M_1) (52.63 g) and Control (M_0) (51.13 g) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) exhibited the higher 100 pod weight (63.13 g) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (59.88 g) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (46.13 g) exhibited lower 100 pod weight on pooled basis.

The interaction between *Phule Unnati*, a groundnut variety and *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing application foliarly recorded the higher 100 pod weight. The same findings were confirmed by Salakinkop and Ashoka (2019) [18], who demonstrated that the yield attributes of groundnut (*Arachis hypogaea* L.) *viz.*, 100 pod weight and pod yield were recorded maximum due to the foliar application. The results of Satpute *et al.* (2021) [19], Abdel-Motagally *et al.* (2016) [1], Shwetha *et al.* (2018) [22] and Noaman *et al*. (2022) [12] provide additional support for these outcomes.

Kernel yield

The highest kernel yield (18.77 q ha^{-1}) reported in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (11.49 q ha^{-1}) on pooled basis. Nevertheless, the foliar application of *Phule* liquid Micro grade II (M_2) found the highest kernel yield (16.99 q ha^{-1}) as compared to soil application of *Phule* Micro grade I (M_1) (15.06 q ha^{-1}) and Control (M_0) (13.34 q ha^{-1}) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) observed the highest kernel yield (20.63 q ha^{-1}) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (18.62 q ha^{-1}) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (9.60 q ha^{-1}) observed lowest kernel yield on pooled basis.

The highest kernel yield ha^{-1} was recorded in the interaction influence of the groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing**.** The results of present investigation are in conformity with the findings of Helmy and Shaban, (2008) [7] who found that the application of micronutrients may be made more efficiently since the foliar spray allows plants to absorb the applied nutrients from the solution through their leaf surface. These findings concurred with those brought to light by Ali and Mowafy (2003) [2], Sonawane *et al*. (2010) [25], El-Saady *et al*. (2014) [5] and Nasar *et al.* (2018) [11]. Senthilkumar (2018) [20] was in opinioned that the increased pods yield was recorded due to foliar application of Fe and Zn and concluded the application of micronutrient through foliar spray increased the crop yield. These results are further supported by the findings of Der *et al*. (2015) [4] who showed that the foliar application K @ 0.5% + Fe @ 0.5% + Zn @ 0.5% + B @ 0.2% at 40 days after sowing found maximum pod yield of groundnut. Similar findings was also reported by Abdel-Motagally *et al.* (2016) [1], Sharma *et al*., (2017) [21], Rajitha et al. (2018) [15], Sabra *et al*. (2019) [17], Satpute *et al.* (2021) [19] and Noaman *et al*. (2022) [12].

100 kernel weight

The higher 100 kernel weight (39.88 g) noted in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (31.96 g) on pooled basis. Nevertheless, the foliar application of *Phule* liquid Micro grade II (M_2) obtained the highest 100 kernel weight (36.88 g) as compared to soil application of *Phule* Micro grade I (M_1) (36.00 g) and Control (M_0) (34.88 g) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II

(V_2M_2) recorded the higher 100 kernel weight (40.63 g) followed by Phule Unnati and soil application of Phule Micro grade I (V_2M_1) (40.25 g) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (31.00 g) found lower 100 kernel weight on pooled basis.

The interaction between *Phule* Unnati, a groundnut variety and Phule liquid Micro grade II @ 1.0% at 35 and 45 days after sowing application foliarly recorded the higher 100 kernel weight. Similar results were also reported by Salakinkop and Ashoka (2019) [18] who found that the yield attributes of groundnut (Arachis hypogaea L.) viz., 100 kernel weight and kernel yield were recorded maximum due to the foliar application. The results of Satpute *et al*. (2021) [19], Abdel-Motagally *et al*. (2016) [1], Shwetha et al. (2018) [22] and Noaman *et al*. (2022) [12] provide additional support for these outcomes. Similar outcomes resemble those attained by Darwish *et al*. (2002) [3] and Ali and Mowafy (2003) [2]. Kader and Mona (2013) [8] stated that foliar application of sulphur, boron and zinc recorded the maximum 100 seeds weight. Similar conclusions were also drawn by Havlin *et al*. (1999) [6].

Shelling outturn

The maximum shelling outturn (66.18%) observed in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (69.30%) on pooled basis. However, the foliar application of *Phule* liquid Micro grade II (M_2) recorded the maximum shelling outturn (69.53%) as compared to soil application of *Phule* Micro grade I (M_1) (67.39%) and Control (M_0) (66.30%) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) exhibited the maximum shelling outturn (67.55%) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (65.60%) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (67.20%) exhibited minimum shelling outturn on pooled basis.

The highest shelling outturn was seen in the interaction between the *Phule Unnati* groundnut variety and the foliar application of *Phule* liquid Grade II @ 1.0% at 35 and 45 days after sowing. The observations of the current investigation are congruent with those drawn by (Nasar *et al*., 2018) [11]. The application of micronutrients may be made more efficiently since the foliar spray allows plants to absorb the applied nutrients from the solution through their leaf surface (Helmy and Shaban, 2008) [7]. Der *et al*. (2015) [4] showed that the foliar application K @ 0.5% + Fe @ 0.5% + Zn @ 0.5% + B @ 0.2% at 40 days after sowing found maximum shelling of groundnut. The findings of Noaman *et al*. (2022) [12] and Sharma *et al*. (2017) [21] support these results**.** Sabra *et al*. (2019) [17] demonstrated the impact of foliar application micronutrients amalgam of zinc, manganese and boron on the groundnut and observed that the higher values for shelling percentage. These findings concurred with those brought to light by Ali and Mowafy (2003) [2], Sonawane *et al*. (2010) [25], and El-Saady *et al*. (2014) [5]. Satpute *et al*. (2021) [19] resulted that the dual Lignite based Liquid based biofertilizers observed highest values summer groundnut for quality traits *viz*., shelling (%) and sound mature kernel (%).

Sound mature kernel

The maximum sound mature kernel (92.42%) observed in groundnut variety *Phule Unnati* (V_2) as compared to SB-XI (V_1) (91.33%) on pooled basis. However, the foliar application of *Phule* liquid Micro grade II (M_2) recorded the maximum sound mature kernel (92.94%) as compared to soil application of *Phule* Micro grade I (M_1) (92.06%) and Control (M_0) (90.63%) on pooled basis. The interaction of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II (V_2M_2) exhibited the maximum sound mature kernel (93.50%) followed by *Phule Unnati* and soil application of *Phule* Micro grade I (V_2M_1) (92.25%) on pooled basis. Whereas, the interaction of groundnut variety SB-XI and control (V_1M_0) (89.75%) exhibited minimum sound mature kernel on pooled basis.

The maximum sound mature kernel was shown in the interaction effect of the groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing. The observations of the current investigation are congruent with those drawn by Nasar *et al*. (2018) [11]. The application of micronutrients may be made more efficiently since the foliar spray allows plants to absorb the applied nutrients from the solution through their leaf surface (Helmy and Shaban, 2008) [7]. Noaman *et al*. (2022) [12] revealed that the interaction between varieties and foliar application of micronutrient had a significant impact on yield attributes of groundnut. Satpute *et al*. (2021) [19] resulted that the dual Lignite based Liquid based biofertilizers observed highest values summer groundnut for quality traits *viz*., shelling (%) and sound mature kernel (%).

Conclusions

It was summarized that the groundnut variety *Phule Unnati* and the foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing recorded the maximum growth and yield attributes. Moreover, it was demonstrated that the combination of groundnut variety *Phule Unnati* with foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing exhibited the highest growth and yield attributes.

It was consequently concluded that the foliar application of *Phule* liquid Micro grade II @ 1.0% at 35 and 45 days after sowing found effective for growth and yield attributes *viz*., number of branches^{-1}, number of pods plant^{-1}, pod yield, 100 pod weight, kernel yield, 100 kernel weight, shelling outturn and sound mature kernel of summer groundnut.

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