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On enhancing mustard productivity through judicious combination of soil and foliar application of nutrients

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In a simple randomised field experiment, the effect of various doses of nitrogen and that of the method of N,P and S application on pods/plant, seeds/pod, hecto-litre weight, seed yield, oil percentage and oil yield of mustard *(Brassica juncea)* var. Varuna was studied. Basal application of 60 kg N (or even 45 kg N)/ha supplemented with the foliar application of 20 kg N + 8 kg P_2O_5 + 2 kg S/ha (in two equal splits at flowering and fruiting) ensured better harvest than even 60 kg basal N/ha + 30 kg top N/ha, although the latter proved superior to 90kg basal N/ha alone. Application of more than 90 kg N/ha either as basal + top - dressing or basal + foliar spray proved deleterious while 45 kg basal N/ha proved insufficient inspite of supplemental nitrogen application as top-dressing or foliar spray.

With the introduction of improved high yielding crops, intensive fertiliser application has become imperative for realising their yield potential but this increases the cost of the products. Also, about 50% applied N (Anonymous, 1971) and 70% P (Russell, 1950) to the soil remain unavailable to many crops due to several factors. It is, therefore, desirable to adopt methods that reduce wastage of nutrients without affecting productivity.

Split application of fertilisers, partly at the time of sowing and partly by top-dressing at appropriate growth stages, is an established practice; but even this results in some loss of the fertilisers. But foliar spray of dilute solutions of nutrients to supplement basal application is convenient, efficacious and economical for some crops, including mustard (Afridi & Wasiuddin, 1979; Paraviz *et al.*, 1982a; Afridi 1983). With this in mind a field experiment was conducted on mustard (*Brassica juncea* L. Czern. & Coss.) c v Varuna to establish the best dose of nitrogen and method of nutrient application out of (1) full basal, (2) basal + top-dressing and (3) basal + foliar spray.

MATERIALS & METHODS

The experiment was conducted in field at Aligarh in a sandy loam soil ($_pH$ - 8.2; available N, P_2O_5 and K_2O - 191, 55 and 1148 kg/ha, respectively) with the variety, Varuna which is found to perform best under local conditions Paraviz, 1980; Mohammad *et al.*, 1983, 1984). The experiment was conducted according to simple randomised block design. The ten treatments selected for study (Table 1) were partly based on the authors, earlier experience (Mohammad *et al.*, 1985, 1986; Simiullah *et al.*, 1985). Each of these treatments was replicated thrice. 40 kg each of basal P_2O_5 and K_2O/ha was applied uniformly. The size of each plot was 10 sq m and the seed rate was 10 kg/ha.

The sources of soil-applied nitrogen, phosphorus and potassium were urea, calcium superphosphate and muriate of potash, respectively. Leaf-applied nitrogen, phosphorus and sulphur were supplied in the form of aqueous solutions of urea, sodium dihydrogen orthophosphate and sodium sulphate, respectively. An insecticide 'Dimecron 100' with water only or with nutrients, at the uniform rate of 250 ml/ha, was sprayed on all the plots to control aphid at flowering and fruiting stages. The field received three irrigations and two weedings between sowing and harvesting. Uniform thinning was done at first weeding in all the plots.

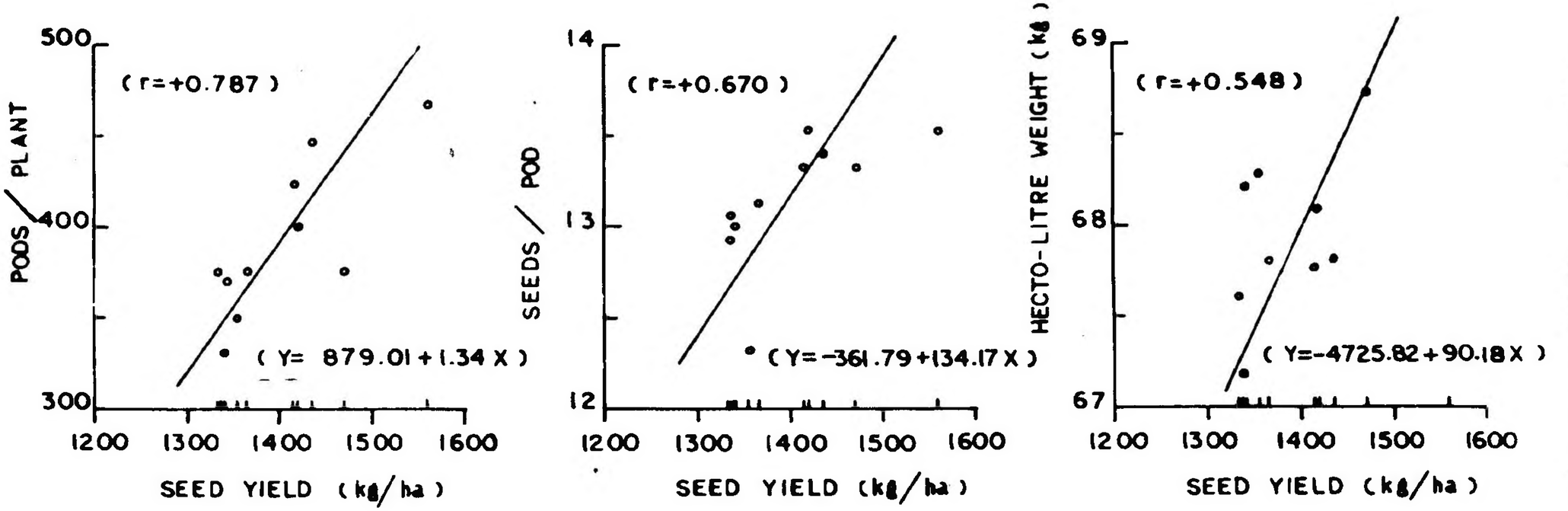
Data were collected at harvest. Five plants were randomly sampled from each plot for the count of pods/plant and seeds/pod. For seed yield and hecto-litre weight of seeds, the entire plot was harvested. Oil was extracted by Soxhlet apparatus using petroleum ether as solvent for determining oil percentage in seeds. Total oil yield was computed on the basis of oil percentage and seed yield.

Table 1 : Scheme of treatments

Treatment	Nutrient applied (kg/ha)			Total N
	Basal dressing (B)	Top-dressing (T)	Foliar spray (F)	
	N	N	N + P_2O_5 + S	
$B_{N90} + F_W$ (control)	90	-	Water	90
$B_{N90} + T_{N20}$	90	20	-	110
$B_{N60} + T_{N30}$	60	30	-	90
$B_{N45} + T_{N45}$	45	45	-	90
$B_{N90} + F_{N20}$	90	-	20 + 0 + 0	110
$B_{N60} + F_{N20}$	60	-	20 + 0 + 0	80
$B_{N45} + F_{N20}$	45	-	20 + 0 + 0	65
$B_{N90} + F_{N20P8S2}$	90	-	20 + 8 + 2	110
$B_{N60} + F_{N20P8S2}$	60	-	20 + 8 + 2	80
$B_{N45} + F_{N20P8S2}$	45	-	20 + 8 + 2	65

A uniform basal dose of 40 kg P_2O_5 and 40 kg K_2O/ha was added to the soil.
Top-dressing and foliar spray were given in two equal splits at 70 days (flowering stage) and 90 days (fruiting stage) of plant growth.

RESULTS & DISCUSSION It is evident from Table 2 that the yield characteristics were affected significantly by various doses of applied N and the methods of nutrient application. Treatment $B_{N60} + F_{N20P8S2}$ proved best for almost all yield attributes, including seed and oil yield giving 23.8% more pods/plant, 3.0% more seeds/pod and 0.8% higher hecto-litre weight than the control. The beneficial effects contributed cumulatively to an increase of 14.3% in seed yield by this treatment as compared to control ($B_{N90} + F_W$). This is corroborated by correlation studies that showed pod number ($r = +0.787$), seed number ($r = +0.670$) and hecto-litre weight ($r = +0.548$) to be significantly and positively correlated with seed yield (Fig. 1). It is note worthy that although the oil percentage in the optimum treatment was at par with that in the control, total oil yield in the former was 13.1% higher, supporting the above statement. Treatment $B_{N60} + F_{N20P8S2}$ was followed by $B_{N45} + F_{N20P8S2}$ with regard to the effect on seed and oil yield. The lowest seed yield was noted in $B_{N90} + T_{N20}$ and the lowest oil yield in $B_{N90} + F_{N20}$, being 2.1% and 10.8% less respectively, than the control. It confirmed our earlier findings (Mohammad *et al.*, 1985) that application of more



Correlation coefficients and regression equations for yield characteristics

than 90 kg N/ha is detrimental for mustard.

Of the three top-dressing treatments, B_{N60} + T_{N30} surpassed B_{N90} + F_{W}. the control, by 3.6% for seed yield and by 2.5% for oil yield (Table 2). However, like B_{N90} + T_{N20} discussed above, B_{N45} + T_{N45} failed to compete with the control (B_{N90} + F_{W}) in seed and oil yield. This could be explained on the basis of the established high basal nitrogen requirement of most of the improved varieties of crops, including mustard (Paraviz 1980; Paraviz *et al.*, 1982b; Afridi *et al.*, 1983; Mohammad *et al.*, 1985, 1986; Samiullah *et al.*, 1985). The basal dose of 45 kg N/ha appeared insufficient for proper maintenance of the plants during early vegetative phase, causing retarded growth. This " hidden hunger", ultimately resulting in poor reproductive growth, was also reflected in the limited pod and seed development and consequently lowered yields.

on comparing the spray treatments of nitrogen with top-dressing (Table 2), the data confirmed the superiority of spray over top-dressing, as also noted by *Bara & Das* (1962, for maize. Thus, B_{N60} + F_{N20} proved superior to B_{N60} + T_{N30} on the basis of higher yield as well as causing a saving of 10 kg N/ha. On the other hand, B_{N45} + $F_{N20,}$ which was at par with B_{N45} + T_{N} in seed yield, showed a saving of 25kg N/ha.

Comparing the effect of treatments B_{N90} + F_{N20P8S} B_{N60} + $F_{N20P8S2}$ and B_{N45} + $F_{N20P8S2}$ with B_{N90} + F_{N} B_{N60} + F_{N20} and B_{N45} + F_{N20} respectively, it wa

Table 2 Effect of various doses of nitrogen and methods of nutrient application onyield characteristics of mustard cv.Varuna (mean of three replicates)

Yield parameter	B_{N90} + F_{W} (control)	B_{N90} + T_{N20}	B_{N60} + T_{N30}	B_{N45} + T_{N45}	B_{N90} + F_{N20}	B_{N60} + F_{N20}	B_{N45} + F_{N20}	B_{N90} + $F_{N20P8S2}$	B_{N60} + $F_{N20P8S2}$	B_{N45} + $F_{N20P8S2}$	C.D. at5%
Pods/ plant	375	373	424	330	370	446	350	401	464	376	9
Seeds/pod	13	13	13	13	13	13	12	14	14	13	0.3
Hecto-litre weight (kg)	68	68	68	68	67	68	68	68	68	69	0.1
Seed yield (kg/ha)	1365	1336	1414	1341	1339	1435	1355	1417	1561	1470	14
Oil per cent	35.4	34.6	35.0	34.7	32.2	32.9	33.7	34.8	35.0	35.1	0.4
Oil yield (kg/ha)	483	462	495	464	430	472	456	493	546	516	7

A uniform basal dose of 40kgP_2O_5 and 40 kg K_2O/ha was added to the soil.
Top-dressing and foliar spray were given in two equal splits at 70 days (flowering stage) and 90 days (fruiting stage) of plant growth.

noted that addition of phosphorus and sulphur to nitrogen spray enhanced both seed and oil yield significantly. This is further confirmed by the findings of the treatment of B_{N90} + $F_{N20P8S2}$ compared to those of B_{N90} + F_{N20} and B_{N90} +T_{N20}. .All the three treatments provided 20 kg N/ha over and above the optimum nitrogen dose for Varuna mustard (Mohammad *et al.*, 1985) either by foliar spray or by top-dressing. However, additional supply of phosphorus and sulphur in B_{N90} + $F_{N20P8S2}$ produced 6.0% and 5.8% more seed and 6.7% and 14.5% more oil than that of B_{N90} + T_{N20} and B_{N90} + F_{N20} respectively, although the optimum treatment (B_{N60} + $F_{N20P8S2}$) increased seed production by 10.2% and oil production by 10.8% compared with that of the treatment of B_{N90} + $F_{N20P8S2}$. Similarly,comparison of the effects of B_{N45} + $F_{N20P8S2}$ with those of B_{N45} + F_{N20} and B_{N45} + T_{N45} also substantiates the beneficial role of phosphorus and sulphur as foliar spray, thus confirming our earlier findings (Paraviz*et al.*, 1982 a, Afridi*et al.*, 1983; Samiullah*et al.*, 1985).

It may, therefore, be concluded that: (1) B_{N60} (or even B_{N45}) + $F_{N20P8S2}$ (in two equal splits at flowering and fruiting) ensured better harvest than B_{N90} or B_{N60} + T_{N30} (which proved better than B_{N90}) or even B_{N60} + F_{N20} which out yielded the latter two treatments;

(ii) application of more than 90 kg N/ha either as basal + top-dressing or basal + spray proved deleterious; and

(iii) application of 45 kg N/ha at the time of sowing proved insufficient inspite of supplemental nitrogen as top-dressing or spray.

It may be emphasised,however,that where facilities for spray application are not available, mustard variety Varuna may be given a basal dose of 60 kg N/ha followed by top-dressing with 30 kg N/ha in two equal splits one at the time of flowering and another at the fruiting stage to ensure increased yield compared with basal application of 90 kg N/ha.

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