supply 75 and 25 per cent inorganic N respectively (4653 kg ha^{-1}). It was observed that fine grain rice, Ponni registered higher yield of 3769 kg ha^{-1} with the combination of organic alone while variety IR20 yielded more (5710 kg ha^{-1}) with the application of inorganics alone (Table 2).

Hence, it is imperative that variety Ponni is highly suitable for organic farming situation. Increased population of 66 hills/m^2 did not give any yield advantage than 50 hills/m^2. Green manuring and neemcake can be used as an alternative source to chemical fertilizer.

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Research Notes

Influence of sulphur on yield and economics in irrigated sunflower (*Helianthus annuus* L.)

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Sulphur (S) is recognized as important secondary nutrient under the macro elements. It is essential for the growth and development of plant besides it stimulates seed formation and increase the oil content in oil seed crops. It's deficiency has been reported from several states of India and importance of sulphur application for increasing crop yield and quality is being increasingly recognized (Tandon, 1989). Poor seed setting has been one of the most commonly encounted problem in sunflower. The average seed setting in India is around 60 per cent and it may be reduced to 20 per cent in certain seasons and locations (Seetharam, 1976). Hence this problem demands greater attention due to its adverse effect on seed yield. There is very little information available regarding the effect of sulphur on sunflower. Therefore, the present investigation was undertaken wth a view to study the effect of different levels of sulphur on yield and economics and to fix the optimum dose of sulphur application for irrigated sunflower.

A field experiment was conducted in red sandy loam soils at Regional Research Station, Paiyur under irrigated condition during *Rabi* 2001 (Dec-Feb). Five levels of sulphur *viz.* 0,15,30,45 and 60 kg/ha combined with the recommended dose of NPK were tried in randomized block design with four replications. The recommended dose of NPK for irrigated sunflower was 40:20:20 kg/ha and the test variety was CO.3. The DAP and urea was used to supply N and P for treatment 1. The single super phosphate (16% 'P' and 12% 'S') @ 125 kg ha^{-1} was applied to supply the recommended dose of P (20 kg ha^{-1}) and sulphur (15 kg ha^{-1}) for treatments 2 to 5. The additional dose of sulphur for treatments 3 to 5 was supplied through gypsum (15% 'S') as per the treatments. A common dose of potassium (20 kg ha^{-1}) was applied through muriate of potash to all treatments.

The plant height and diameter of capitulum were not significantly influenced by the application of different levels of sulphur. However, the yield attributes *viz.* number of grains/capitulum and test weight were significantly influenced by the levels of sulphur application. The number of grains and test weight were significantly

Table 1. Effect of levels of sulphur on yield and economics in irrigated sunflower

Tr. No.	Treatments	Plant height (cm)	Capi-tulam diameter (cm)	Grains/ capi-tulum	Test weight (g)	Grain yield (kg ha^{-1})	Net income (Rs ha^{-1})	BC ratio
T1	Control (No S)	171.7	11.15	31.25	5.88	1202	3403	1.55
T2	15 kg 'S' ha^{-1} (as SSP)	155.0	10.33	31.70	5.85	1254	3682	1.58
T3	30 kg 'S' ha^{-1} (15 kg 'S' as SSP + 15 kg 'S' as gypsum)	156.0	11.83	33.95	6.68	1303	3924	1.60
T4	45 kg 'S' ha^{-1} (15 kg 'S' as SSP + 30 kg 'S' as gypsum)	156.7	11.48	35.40	6.73	1414	4512	1.70
T5	60 kg 'S' ha^{-1} (15 kg 'S' as SSP + 45 kg 'S' as gypsum)	164.3	11.50	35.40	6.73	1441	4728	1.70
	CD at 5%	NS	NS	3.00	0.24	44	NA	NA

higher at 45 and 60 kg 'S' ha^{-1}. Similarly, application of graded levels of sulphur significantly increased the grain yield linearly and the increase was 4,8,17 and 20 per cent over no sulphur application. The grain yield was significantly maximum (1441 kg ha^{-1}) at 60 kg 'S' ha^{-1} and it was on par with 45 kg 'S'ha^{-1} (1414 kg ha^{-1}). Bansal (1991) found increased seed yield of soybean at increased levels of sulphur from 0 to 80 kg ha^{-1} and the yield difference was not significant at 40 to 80 kg ha^{-1}. The highest net income was obtained at 60 kg 'S' ha^{-1} (Rs.4728 ha^{-1}) and the increase was not much appreciable as compared to 45 kg 'S' ha^{-1} (Rs.4512 ha^{-1}) and the benefit cost ratio was equal at 45 and 60 kg 'S' ha^{-1}. Hence it could be concluded that the sulphur 45 kg ha^{-1} may be applied to irrigated sunflower for higher yield and net income.

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Research Notes

Effect of growth regulators on yield, nutrient uptake, economics and energy out-put of pigeon pea (*Cajanus cajan* (L.) Millsp) genotypes

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Pigeonpea (*Cajanus cajan* (L.) Millsp) cultivation in Chhattisgarh state occupies a distinct position in the pulse map of India occupying an area of 0.27m ha with a production of 0.118m t and productivity of 445 kg/ha and productivity of pigeonpea can be ascribed to the constraints associated with its agro-ecological and physio-morphological traits. Pigeonpea

Table 1. Effect of genotypes and growth regulators on N,P,K and protein content in seed and stalk of pigeonpea

Treatment	Content (%)							
	Nitrogen		Phosphorus		Potassium		Protein	
	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk
Genotypes								
Asha	3.36	0.85	0.24	0.08	0.45	0.74	21.37	5.09
C-11	3.57	0.91	0.31	0.09	0.50	0.83	22.38	5.89
SEm ±	0.11	0.01	0.008	0.001	0.008	0.010	0.31	0.16
CD (P=0.05)	0.33	0.04	0.024	0.003	0.024	0.033	0.93	0.49
Growth regulators								
Control	3.34	0.83	0.23	0.08	0.45	0.78	20.90	5.22
2,4-D @ 20 ppm	3.57	0.85	0.30	0.08	0.50	0.77	22.88	5.30
Cycocel @ 1000 ppm	3.49	1.00	0.25	0.09	0.47	0.80	21.84	6.11
SEm ±	0.18	0.03	0.010	0.003	0.010	0.013	0.40	0.20
CD (P=0.05)	NS	0.09	0.030	0.009	0.030	NS	1.20	0.60

Table 2. Effect of genotypes and growth regulators on N,P,K and protein content and yield of seed and stalk of pigeonpea

Treatment	Nutrient uptake (kg ha^{-1})						Protein yield		Yield (kg ha^{-1})	
	Nitrogen		Phosphorus		Potassium					
	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed
Genotypes										
Asha	71.44	74.97	4.34	6.49	9.45	69.03	454.79	467.01	21.12	93.25
C-11	59.25	71.18	5.18	7.35	8.15	68.49	375.30	475.81	16.80	81.87
SEm ±	2.72	1.22	0.22	0.28	0.27	1.06	17.09	15.19	0.55	0.99
CD (P=0.05)	8.20	3.67	0.66	0.84	0.81	NS	51.09	NS	1.66	2.99
Growth regulators										
Control	57.77	73.25	4.58	6.66	7.80	68.99	361.04	457.61	17.28	87.99
2,4-D @ 20 ppm	66.46	69.84	5.55	7.33	9.31	70.52	415.37	484.35	18.58	91.36
Cycocel @ 1000 ppm	71.79	76.12	5.06	6.77	9.31	66.76	465.72	472.27	21.02	83.33
SEm ±	3.33	1.94	0.27	0.32	0.33	1.30	18.32	18.60	0.68	1.21
CD (P=0.05)	10.05	5.84	0.81	NS	0.99	NS	55.20	NS	2.04	3.66

genotypes have been classified into early, medium and long duration types, each forming a different production system. The expression of variability for different characters differs among the various production systems. Thus, a generalized production strategy cannot be formulated for pigeonpea (Sachan, 1992). Plant growth substances play a significant role in modification of crop growth yield and quality of crop (Randhawa and Singh 1970; Pando and Shrivastava, 1985 and Wang and Zapata, 1987). Agro-ecological situations management factors and renewable energy sources affects the crop production. Considering these points this study was undertaken to assess the

Table 3. Energetics and economics of pigeonpea as effected by genotypes and growth regulators

Treatment	Energy input (MJ x 10^{-3} ha^{-1})	Energy input (MJ x 10^{-3} ha^{-1})	Energy output input ratio	Energy use efficiency (q MJ x 10^{-3} ha^{-1})	Cost incurred (Rs ha^{-1})	Gross realization (Rs ha^{-1})	Net realization	
							Rs ha^{-1}	Re^{-1} invested
Genotypes								
Asha	7.97	14.95	18.93	14.67	14052	3730	21371	2.57
C-11	7.79	127.08	16.30	12.66	14052	3275	14553	2.02
SEm ±	-	1.61	0.21	0.16	-	872	419	0.06
CD (P=0.05)	-	4.84	0.62	0.47	-	2028	1264	0.19
Growth regulators								
Control	7.76	132.76	17.43	13.56	13632	29449	15817	2.15
2,4-D @ 20 ppm	7.77	141.69	18.23	14.16	13938	31724	17786	2.22
Cycocel @ 1000 ppm	7.85	135.10	17.20	12.08	14588	34871	20283	2.53
SEm ±	-	1.87	0.25	0.19	-	1068	603	0.08
CD (P=0.05)	-	5.66	0.76	0.58	-	3218	1316	0.24

effect of genotypes and growth regulators on nutrient uptake, economics and energy output of pigeonpea in *vertisols* of Chhattisgarh plains.

A field experiment was conducted during *kharif* season of 2000-2001 at IGAU, Raipur on *vertisols* having a pH of 7.19 with available NPK 218, 12.15 and 363 kg ha^{-1}, respectively. Climate of the region is dry moist, sub-humid with average rainfall of 1200-1400 mm. The crop received 1214mm rainfall during the growth period. The experiment was laid out in a RBD (factorial) with four replications. The treatments consisted of three growth regulators (control, 2,4-D @ 200 ppm and cycocel @ 1000ppm) and two pigeonpea genotypes (Asha and C-11). Pigeonpea seeds were sown at a seed rate of 20 kg ha^{-1} on 5th August, 2000 with a spacing of 60 cm x 15 cm. Recommended fertilizer dose @ 20:50:30 kg NPK ha^{-1} was applied uniformly. Harvesting was done on 2nd February, 2001. The N,P and K content in seed and stalks were estimated by micro kjeldahl method, vanado molybdo phosphoric yellow colour method and flame photometry, respectively as described by (Jackson, 1967). Protein content, NPK uptake, energetics and economics were also worked out by respective formulae. Cost of production for all treatments was worked out on the basis of the prevailing input and market price of the produce.

Results revealed that the N,P and K content in seed and stalk was significantly higher in cv.C-11 than cv.Asha (Table 1). This is due to the dilution effect on account of higher biological yield of cv. Asha. The N and K uptake were found to be higher in cv.Asha, eventhough their concentrations was low; it is due to higher biological yield of cv.Asha (Table 2). But the phosphorus uptake followed the exact pattern of its concentration. The protein content being a function of nitrogen content is obvious to follow a similar trend as that of nitrogen. But the protein yield was statistically higher in cv.Asha because of higher productivity (Table 2). Jarillo *et al.* (1998) also found that the highest seed yields were generally correlated with relatively high crude protein content.

As regards to economics comparison of both cultivars, the gross and net realization estimated to be significantly higher in cv.Asha than C-11 (Table 3). This high return in cv.Asha might be due to higher productivity. Energetics in relation to energy input, output input ratio and use efficiency significantly higher with cv.Asha, due to higher energy output, which is nothing but the outcome of higher yield (Table 3).

Growth regulators caused variation in N,P,K content in plant. The higher seed N, P and

K contents were observed in 2,4-D treatment, but their concentration in stalk were higher in cycocel treatment (Table 1). On the contrary, Shende *et al.* (1987) observed increased N and P contents in seed due to foliar spray of cycocel. Since, the seed yield in 2,4-D was less as compared to cycocel a comparatively lower seed nutrient concentration in cycocel, might be due to dilution effect. This was also noticed in case of stalk yield, but because the stalk yield was higher in 2,4-D, its nutrients concentration was found to be lower. Low N concentration was found in seed due to cycocel, but its uptake was highest due to higher yield. Higher N uptake in stalk is positively correlated with high N concentration in it. The seed P concentration was the highest in 2,4-D which ultimately resulted in higher seed P uptake, but highest P uptake, inspite of low stalk P concentration might be due to higher stalk yield. As regards seed K uptake, 2,4-D and cycocel had the similar values, which was significantly higher than the control. But in case of stalk, the K uptake was highest in 2,4-D obviously due to higher stalk yield (Table 2). The protein content based on N concentration obviously followed similar trend of nitrogen. Highest seed protein content was observed in 2,4-D, which corroborates the findings of Barriobera *et al.* (1995). Protein yield was found to be highest in cycocel and 2,4-D in seed and stalk respectively. The results revealed that between the genotypes, cv. Asha recorded highest seed (21.12 q ha^{-1}) and stalk (93.25 q ha^{-1}) yield. In respect of growth regulators, cycocel produced significantly higher seed yield, which was 87.97 and 81.81 per cent higher over 2,4-D and control, respectively. But the stalk yield was the highest in 2,4-D treatment.

Economics of pigeonpea production was influenced by growth regulators. Highest gross realization and net realization were found in cycocel treatment (Table 3). Gupta (2000) also observed higher gross and net return with cycocel application. From energy considerations, the energy output, energy output input ratio and energy use efficiency were highest in case of 2,4-D due to highest biological yield coupled with low energy input on accounts of its application of a lower concentration.

Although cv.Asha and application of 2,4-D @ 20 ppm increased NPK content, but from economics and energy considerations cv. Asha and cycocel spray was the most viable.

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