*fasciculatus,* phosphate solubilizing fungus *Aspergillus niger* and *Penicillium.* Ramaswami and Kothandaraman (1991) reported that application of composted coirpith decreased the soil bulk density and increased the soil moisture and hydraulic conductivity. Furthermore, composted coirpith was low in phosphorus content which may be the reason for the stimulation of infective propagules. An ideal substrate is expected to be low in organic matter and nutrients. Inhibition of VAM by higher concentration of phosphorus, manganese and zinc is well established. Composted coirpith is cheaper and easily available and so it could be used as substrate for VAM inoculum production.

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# YIELD OF RICE CULTIVARS UNDER DIFFERENT METHODS OF ESTABLISHMENT AND SCHEDULES OF IRRIGATION

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## ABSTRACT

Investigations carried out at the Agricultural Research Station, Aliyarnagar, Tamil Nadu, India during 1993-94 and 1994-95 revealed that irrigation one day after disappearance of ponded water is the optimum irrigation regime for rice. Water requirement of rice varied from 932 mm to 1138 mm based on the irrigation regime and variety. The management practices of maintaining a population of 33 hills $m^{-2}$ adopting equidistant method of planting four seedlings $hill^{-1}$ proved to be feasible and best for yield maximisation under conditions of labour shortage. Varieties CO 45 and ADT 38 performed better than IR 20 with regard to grain yield and economics.

KEY WORDS : Rice, irrigation regimes, planting geometry, yield, water requirement

Rice consumes 60 per cent of irrigated water to all crops in India. Irrigation one day after disappearance of ponded water gave yields comparable to that of continuous submergence, besides resulting in considerable saving of water applied (Palchamy *et al.,* 1989). There are also reports indicating that irrigation could be withheld for two to three days after disappearance of ponded water without any yield reduction (Subramaniam, 1994). Agronomic measures like planting geometry and number of seedlings $hill^{-1}$ influence the yield components such as number of productive tillers unit $area^{-1}$ and number of filled gains $panicle^{-1}$, which in turn affect the rice yield. Alexander *et al.* (1988) reported that by increasing the spacing from 20 x 10 cm to 20 x 15 cm, grain yield was not significantly altered. Zhang and Huang (1990) reported that grain yield $hill^{-1}$ increased by planting more number of seedlings $hill^{-1}$. Singh and Singh (1992) reported that transplanting 2 or 4 seedlings hill$^{-1}$ increased the grain yield significantly. However, reduction in grain yield was observed when six seedlings hill$^{-1}$ were transplanted. Thus it is clear that possibilities exist for economising irrigation water in rice and that rice shows wide plasticity to plant population. Hence, the present study was undertaken to evolve a package of agronomic practices aiming maximization of rice yield under conditions of water and labour shortage.

## MATERIALS AND METHODS

Field experiments were conducted during October-January seasons for two consecutive years (1993-94 and 1994-95) at the Agricultural Research Station, Aliyarnagar. The location is geographically situated at 10°39'5" N latitude and 77°0'5"E longitude at an altitude of 260 m above mean sea level. The soil of the experimental field was sandy loam, low in available nitrogen (230 kg ha$^{-1}$), medium in available phosphorus (12.5 kg ha$^{-1}$) and potassium (250 kg ha$^{-1}$). The pH of the experimental field was 7.3 with bulk density 1.3 g cc$^{-1}$. Particle size analysis showed that the experimental field had 14% clay, 7.86% silt, 46.63% fine sand and 30.66% coarse sand. Field capacity and permanent wilting point were 20.4 and 10.4 per cent respectively. The experimental field was irrigated by well water with pH of 7.9 and EC of 0.6 dSm$^{-1}$. R.S.C. of irrigation water was 0.1 mel$^{-1}$ and S.A.R. value wa 2.4. During 1993-94 cropping season, medium duration rice variety IR 20 was the test crop, and during 1994-95, besides IR 20, ADT 38 and CO 45 released by Tamil Nadu Agricultural University, were also raised as per treatments.

The experiments were laid out in split-split plot design with there replications. The experimental details are furnished below :

A. Mainplot (Irrigation regimes - irrigation to 5 cm depth)

$I_1$ - Irrigation one day after disappearance of ponded water

$I_2$ - Irrigation three days after disappearance of ponded water

B. Sub-plot (planting geometry)

$P_1$ - 50 hills m$^{-2}$, rectangular planting (20 x 10 cm)

$P_2$ - 50 hills m$^{-2}$, equidistant planting (14.1 x 14.1 cm)

$P_3$ - 33 hills m$^{-2}$, rectangular planting (20 x 15 cm)

$P_4$ - 33 hills m$^{-2}$, equidistant planting (17.4 x 17.4 cm)

C. Sub-sub-plot (Number of seedlings)

$S_1$ - 2 seedlings hill$^{-1}$

$S_2$ - 4 seedlings hill$^{-1}$

$S_3$ - 6 seedlings hill$^{-1}$

During the second year of the trial (1994-95), only sub-subplot treatments were altered as indicated below :

$V_1$ - IR 20

$V_2$ - ADT 38

$V_3$ - CO 45

Gross plot size was 4.8 m x 4.2 m and net plot size 4.0 m x 3.8 m.

After thorough mainfield preparation, individual plots were laidout with provisions of buffer channel between two bunds. A fertilizer schedule of 150:50:50 kg NPK ha$^{-1}$ was followed. Rice seedlings were transplanted as per the different treatments. Shallow submergence was maintained for establishment of seedlings till one week after transplanting in all the treatments. Thereafter, irrigation was given to 5 cm depth one day and there days after disappearance of ponded water for $I_1$ and $I_2$, respectively. Irrigation water was measured using a Parshall flume of 7.5 cm throat width. Irrigation was stopped 7 days before the harvest of the crop. Plant observations and yield were recorded in accordance with standard procedures and are presented in Table 1. Data on field water requirement are presented in Table 2.

Table 1. Effect of treatment on growth and yield attributes, yield and economics

| Treatment | Plant height (cm) at harvest | | No. of tillers $hill^{-1}$ | | Lead area index | | No. of panicles $m^{-2}$ | | No. of filled grains $panicle^{-1}$ | | Thousand grain weight (g) | | Grain yield (kg ha-1) | | Straw yield ($kg\ ha^{-1}$) | | Net returns ($Rs\ ha^{-1}$) | | Benefit cost ratio | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 | 1994 | 1995 |
| $I_1$ | 74.2 | 81.9 | 12.9 | 14.1 | 5.91 | 8.18 | 426 | 457 | 104.8 | 116.6 | 20.33 | 23.09 | 5704 | 6289 | 6703 | 7340 | 21296 | 24596 | 3.02 | 3.05 |
| $I_2$ | 72.3 | 80.8 | 12.4 | 13.4 | 5.77 | 7.84 | 394 | 430 | 96.9 | 110.9 | 20.06 | 22.94 | 5513 | 6085 | 6511 | 7121 | 20513 | 23697 | 2.99 | 3.31 |
| $SE_d$ | 0.12 | 0.17 | 0.12 | 0.16 | 0.03 | 0.19 | 0.8 | 0.8 | 1.01 | 0.95 | 0.15 | 0.11 | 26.1 | 41.2 | 15.7 | 30.7 | - | - | - | - |
| CD | 0.51 | 0.73 | 0.53 | 0.68 | 0.14 | NS | 3.5 | 3.2 | 4.34 | 4.07 | NS | NS | 112.2 | 117.3 | 67.5 | 131.9 | - | - | - | - |
| $P_1$ | 72.3 | 79.6 | 11.8 | 12.8 | 5.94 | 8.38 | 450 | 487 | 95.2 | 108.5 | 19.97 | 22.75 | 5660 | 6246 | 6808 | 7343 | 21038 | 24316 | 2.98 | 3.29 |
| $P_2$ | 71.9 | 80.4 | 11.6 | 12.9 | 5.99 | 8.05 | 444 | 483 | 93.5 | 107.8 | 19.92 | 22.91 | 5632 | 6218 | 6771 | 7336 | 21047 | 24282 | 3.00 | 3.32 |
| $P_3$ | 74.7 | 83.0 | 13.7 | 14.5 | 5.75 | 7.87 | 376 | 400 | 107.7 | 118.7 | 20.48 | 23.09 | 5588 | 6158 | 6442 | 7125 | 20765 | 23991 | 3.00 | 3.32 |
| $P_4$ | 74.1 | 82.3 | 13.5 | 15.0 | 5.68 | 7.73 | 371 | 404 | 107.2 | 119.9 | 20.41 | 23.31 | 5556 | 6127 | 6409 | 7117 | 20767 | 24002 | 3.03 | 3.35 |
| $SE_d$ | 0.18 | 0.56 | 0.15 | 0.08 | 0.03 | 0.25 | 3.0 | 3.8 | 0.99 | 0.75 | 0.09 | 0.18 | 49.5 | 50.6 | 39.5 | 24.9 | - | - | - | - |
| CD | 0.40 | 1.23 | 0.33 | 0.34 | 0.06 | NS | 6.5 | 8.3 | 2.2 | 1.64 | 0.21 | NS | NS | NS | 86.1 | 54.3 | - | - | - | - |
| $S_1V_1$ | 72.8 | 74.1 | 12.5 | 12.8 | 5.85 | 7.21 | 405 | 406 | 100.4 | 102.2 | 20.19 | 20.83 | 5586 | 5875 | 6576 | 6985 | 20879 | 22541 | 3.02 | 3.18 |
| $S_2V_2$ | 74.3 | 83.8 | 13.2 | 14.3 | 5.95 | 8.33 | 442 | 463 | 102.1 | 120.6 | 20.30 | 22.69 | 5685 | 6331 | 6703 | 7335 | 21348 | 24890 | 3.04 | 3.38 |
| $S_3V_3$ | 72.6 | 86.2 | 12.3 | 14.2 | 5.72 | 8.49 | 383 | 461 | 110.1 | 118.5 | 20.10 | 25.52 | 5555 | 6355 | 6544 | 7371 | 20486 | 25103 | 2.94 | 3.40 |
| $SE_d$ | 0.12 | 0.69 | 0.14 | 0.18 | 0.04 | 0.18 | 1.7 | 1.8 | 0.93 | 0.68 | 0.09 | 0.12 | 30.5 | 41.6 | 28.6 | 35.8 | | | | |
| CD | 0.24 | 1.40 | 0.29 | 0.38 | 0.08 | 0.36 | 3.4 | 3.7 | NS | 1.39 | NS | 0.24 | 62.2 | 84.7 | 58.2 | 73.0 | | | | |

Note : $I_1$ - Irrigation one day after disappearance of ponded water
$I_2$ - Irrigation three days after disappearances of ponded water
$P_1$ - 50 hills $m^{-2}$ rectangular planting (20 x 10 cm)
$P_2$ - 50 hills $m^{-2}$ equidistant planting (14.1 x 14.1 cm)
$P_3$ - 33 hills $m^{-2}$, rectangular planting (20 x 15 cm)
$P_4$ - 33 hills $m^2$ equidistant planting (17.4 x 17.4 cm)
$S_1$ - 2 seedlings $hill^{-1}$
$S_2$ - 4 seedlings $hill^{-1}$
$S_3$ - 6 seedlings $hill^{-1}$
$V_1$ - IR 20
$V_2$ - ADT 38
$V_3$ - CO 45

Table 2. Field water requirement (mm)

| | 1993-94 | | | 1994-95 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Water applied | Effective rainfall | Total water used | Water applied | | Effective rainfall | | Total water used | |
| | | | | IR 20 | ADT 38 & CO 45 | IR 20 | ADT 38 & CO 45 | IR 20 | ADT 38 & CO 45 |
| $I_1$ (irrigation one day after disappearance of water) | 750 | 282 | 1032 | 700 | 750 | 388 | 388 | 1088 | 1138 |
| $I_2$ (irrigation three days after disappearance of water) | 650 | 282 | 932 | 600 | 650 | 388 | 388 | 988 | 1038 |

## RESULTS AND DISCUSSION

### Growth attributes

Plant height, number of tillers hill$^{-1}$ and leaf area index (LAI) were significantly higher at irrigation scheduled one day after disappearance of ponded water ($I_1$) compared to irrigation three days after disappearance of ponded water ($I_2$). Increasing irrigation interval led to a progressive decrease in the plant height of rice due to its adverse effect on cell division and cell enlargement (Packiaraj and Venkataraman, 1991). The reduction in the production of tillers at $I_2$ could be attributed to the moisture stress as reported by Reddy and Raju (1987). Leaf area expansion is highly sensitive to moisture stress. In addition, rice tends to adjust the transpiring leaf area through earlier senescence of lower leaves, death of tillers and leaf tip drying resulting in lower LAI (Turner, 1982). These may be the causes for lower LAI recorded in $I_2$.

Wider planting of maintaining 33 hills m$^{-2}$ ($P_3$ and $P_4$) resulted in increased plant height and number of tillers hill$^{-1}$ as compared to 50 hill m$^{-2}$ ($P_1$ and $P_2$). Satyavarma *et al.* (1991) also reported increased plant height and increased number of tillers hill$^{-1}$, respectively, due to wider planting. However, in case of leaf area index (LAI), higher LAI was recorded in $P_1$ and $P_2$ compared to $P_3$ and $P_4$. Majumdar *et al.* (1989) have also reported that by increasing the row spacing from 15 to 20 cm, the LAI was reduced. Method of planting, rectangular or equidistant did not significantly influence the growth characters.

With reference to number of seedlings hill$^{-1}$, planting four seedlings hill$^{-1}$ ($S_2$) recorded significantly increased plant height, number of tillers hill$^{-1}$ and LAI compared to two ($S_1$) and six seedlings ($S_3$) hill$^{-1}$. At $S_3$, probably mutual shading occurred within the hills because of planting more number of seedlings hill$^{-1}$, which affected growth and tiller production. Among the varieties, CO 45 ($V_3$) and ADT 38 ($V_2$) produced taller plants, more number of tillers hill$^{-1}$ and LAI compared to IR 20 ($V_1$).

### Yield attributes

Number of panicles m$^{-2}$ and number of filled grains panicle$^{-1}$ were significantly higher under irrigation at one day after disappearance of ponded water ($I_1$). The reduction in these parameters in $I_2$ could be due to moisture stress as observed by Palchamy *et al.* (1989) and Packiaraj and Venkataraman (1991). Thousand grain weight was not influenced by the irrigation regimes.

With regard to the effect of planting geometry, number of filled grains panicle$^{-1}$ and thousand grain weight were higher at wider planting of 33 hills$^{-2}$ ($P_3$ and P4) compared to 50 hills m-2 ($P_1$ and $P_2$) and did not differ between rectangular and equidistant planting. This is attributable to better growth of individual plants recorded at wider planting, which caused higher photosynthesis and efficient translocation to sink, thus resulting in more number of grains and increased thousand grain weight. Majumdar *et al.* (1989) and Ajay Prasad Kanungo and Roul (1994) have also reported increase in the number of grains panicle$^{-1}$ and thousand grain weight under wider planting. However, higher number of panicle m$^{-2}$ was recorded at the population level of 50 hills m$^{-2}$ compared to wider planting. This is in accordance with the findings of Satya Varma *et al.* (1991).

Number of seedlings planted hill$^{-1}$ did not significantly influence the number of filled grains panicle$^{-1}$ and thousand grain weight. However, planting 4 seedlings hill$^{-1}$ ($S_2$) resulted in higher number of panicles m$^{-2}$ compared to 2 or 6 seedlings hill$^{-1}$, which is attributable to better growth and tiller production under this treatment. This confirms the findings of Singh and Singh (1992). Among the varieties, CO 45 and ADT 38 recorded higher values of yield attributes compared to IR 20.

**Grain and straw yield**

Irrigation one day after disappearance of ponded water ($I_1$) recorded higher grain and straw yield compared to irrigation three days after disappearance of ponded water ($I_2$). Higher tiller production under $I_1$ favoured greater production of panicles. It is possible that enhanced nutrient availability under high irrigation regime promoted the supply of assimilates to 'sink', thus resulting in more number of spikelets. Efficient filling of more number of spikelets resulted in greater number of filled grains with higher grain weight. The yield increase obtained in $I_1$ was therefore the cumulative effect of increase in all the parameters.

Planting geometry did not influence grain yield. It was observed that all the growth parameters like plant height and number of tillers hill$^{-1}$ as well as yield parameters like number of filled grains panicle$^{-1}$ and thousand grain weight were higher at wider planting of 33 hills m$^{-2}$ ($P_3$ and $P_4$). However, number of panicles m$^{-2}$ was significantly reduced under wider planting compared to the population level of 50 hills m$^{-2}$ ($P_1$ and $P_2$), which offset the effect of higher values of yield parameters in individual hills and this ultimately led to similar yield levels. Method of planting, rectangular or equidistant did not affect the grain yield. This could be attributed to similar performance in growth and yield attributes recorded in these two methods of planting.

Planting 4 seedlings hill$^{-1}$ ($S_2$) recorded higher grain and straw yield compared to planting 2 or 6 seedlings hill$^{-1}$, which could be attributed to better growth and yield parameters recorded in this treatment. This result confirms the findings of Satya Varma *et al.* (1991) and Singh and Singh (1992). CO 45 and ADT 38 recorded higher grain and straw yield compared to IR 20.

**Economics**

Irrigation one day after disappearance of ponded water ($I_1$) recorded higher net returns and benefit cost ratio (B-C ratio) due to higher grain yield obtained in this treatment.

With reference to planting geometry, net returns and B-C ratio did not differ much due to treatments. Thus in 1993, $P_1$, $P_2$, $P_3$ and $P_4$ recorded net returns of Rs. 21,038, Rs. 21,047, Rs. 20,765 and Rs. 20,767 ha$^{-1}$. The difference between $P_1$ and $P_2$ was only Rs. 9 ha$^{-1}$ and that between $P_3$ and $P_4$ Rs. 2 ha$^{-1}$. Hence at a given population level, net returns and B-C ratio did not differ much by adopting either rectangular or equidistant planting. Also comparing the net returns at $P_1$ and $P_2$ (50 hills m$^{-2}$) with that of $P_3$ and $P_4$ (33 hills m$^{-2}$), reduction in net returns was only Rs. 277 ha$^{-1}$. Similar trend was noticed in case of benefit cost ratio also.

Net returns and B-C ratio were high by planting 4 seedlings hill$^{-1}$, which is attributed to increase in grain yield obtained in this treatment. Economic analysis favoured growing Co 45 and ADT 38 in place of IR 20, as higher net returns and B-C ratio were recorded in these varieties.

**Field water requirement**

Data on the quantity of water applied, effective rainfall and total water used in 1994 and 1995 are presented in Table 2.

Results showed that irrigation one day after disappearance of ponded water ($I_1$) consumed more water than irrigation three days after disappearance of water ($I_2$). Field water requirement of IR 20 was 1032 and 1088 mm in $I_1$ and 932 and 988 mm under $I_2$ during 1994 and 1995 respectively. Field water requirement of ADT 38 and CO 45 was higher compared to IR 20. Water requirement of ADT 38 and CO 45 in $I_1$ irrigation regime was 1138 mm compared to 1038 mm in $I_2$. Delay in submergence ($I_2$) resulted in considerable water saving. In IR 20, the water saving in $I_2$ compared to $I_1$ was 10.7 per cent during 1994 and 10.1 per cent in 1995. Water saving in ADT 38 and CO 45 due to adoption of $I_2$ irrigation level compared to $I_1$ was 9.6 per cent.


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# GENETIC VARIABILITY IN ONION

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## ABSTRACT

Studies on genetic variability in onion exhibited significant differences among the ecotypes for most of the characters except for shape index indicating high magnitude of variability. The estimates of phenotypic coefficient of variation were high as compared to genotypic coefficient of variation. Very high values for heritability were observed for the characters, volume of bulb (96.50 %) followed by bulb yield (91.62%). All other characters showed high heritability except for pyruvic acid content (14.99%). The characters like weight of plant, bulb length, bulb diameter, volume of bulb and bulb yield per plant recorded very high heritability estimates coupled with high genetic advance guiding for improvement of these characters by selection.


KEY WORDS : Variability, heritability, genetic advance, onion

Onion (*Allium cepa* L. var. aggregatum Don.) is an important vegetable cum condiment growth throughout the tropical and subtropical belt of the world. The production and demand of onion is relatively high and India is one of the leading exporters of onion. The crop is cultivated in different parts of the country due to its wide genetic diversity. This variability is of immense importance to the onion breeder as well as onion industry. Because of the high degree of cross pollination, such genetic variation exists in this crop and various studies on onion varieties showed that there were significant differences among the varieties with respect to yield and other characters. Partitioning of overall variability into heritable and non-heritable effects will help in developing a suitable breeding programme. Hence the present investigation was undertaken to estimate the magnitude of genetic variability in various onion cultivars.

## MATERIALS AND METHODS

The material for the present investigation comprised of 20 onion ecotypes. These were grown