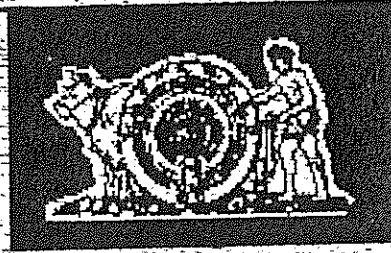
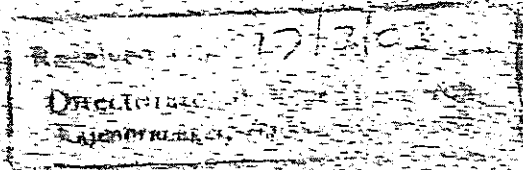


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## Influence of Pre-sowing Seed Treatment on Speed of Germination (Seed Vigour) Flowering and yield in Marigold at Different Planting Dates

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### ABSTRACT

The effectiveness of pre - sowing seed treatments on germination, speed of germination (Seed vigour), field establishment, flowering and yield of *Tagetes erecta L* and *Tagetes patula L* were studied for their possible inclusion in the crop production strategy. Water soaking for 24 hrs. before sowing was found to be the best treatment. Seeds soaked or immersed in distilled water at 25°C for 24 hrs germinated earlier by 2-3 days in African marigold and 1-2 days in French marigold compared to dry seed sowing (control). Significant differences between the treatments were evident. Sowing of pre-soaked seeds resulted in higher germination and vigour, rapid and uniform seedling emergence and better seedling establishment, early flowering and higher yields. Storage of hydrated, dried seeds at 15°C for 6 months resulted in reduced total germination and the potential capacity for rapid germination.

**Key Words :** Germination, Flowering, Marigold, Planting Dates

Marigold is one of the most popular annual flower crop grown all over India for various commercial purposes such as loose flowers, extraction of carotenoid pigments, essential oil and dry flower making apart from its traditional uses as a garden plant, nematode-repellent as well as a trap crop in integrated pest management programmes of agricultural crops. Industrial uses of carotenoids include pharmaceuticals, food supplements, animal feed additives and colourants in cosmetics. In recent years both area and production of loose flowers has increased substantially and the crop is grown in an area of about 17,700 hectares in different states of the country producing nearly 1.6 lakh tonnes of fresh flowers. In most parts of the country, small and marginal farmers grow marigolds in small areas and it goes uncounted for when the statistics are compiled. Hence, the actual area under this crop is likely to be much higher. According to Ar. Sukumar (2000), Andhra Pradesh stands first with the highest area of 4500 ha under its cultivation

producing 30,000 metric tonnes of fresh flowers (52.2% of traditional flowers).

Marigold is mostly sown in October / November months. But the demand for loose flowers peaks up around festival times, particularly in October - November. The xanthophyl pigment (carotenoid pigment) and essential oil extraction units have the year round requirement where as dry flower industry needs flowers mostly in dry season of the year.

Priming (in which seeds imbibe sufficient water to begin the process of germination to a pre-determined point) seeds in osmotic solutions of polyethylene glycol (PEG) 8000 of  $K_3PO_4$  and  $KNO_3$  salts as Osmotica improved the germination of *Impatiens (Impatiens Wallerana Hook)* (Simmonds, 1980), lettuce (*Lactuca Sativa L.*) (Cantliffe, 1981), *Salvia* (Carpenter, 1989) and tomato (*Lycopersicon esculentum*) (Rumpel and Szudyga, 1978) at excessively high temperatures. No recommendations have been reported for priming marigold seeds so far.

In the present study, the sowing of marigold seeds was advanced to explore the possibility of producing flowers to coincide with the seasonal demands. Simple seed treatments were given to see their possible use in improving the rapid and uniform germination, seedling emergence and establishment, flowering and yield in off-season sowings under different dates of sowing.

### MATERIAL AND METHODS

Field experiment was conducted at The Division of Floriculture and Landscaping, IARI, New Delhi, during 1998 - 99 season in split plot design with planting dates as main treatments and seed treatments as sub treatments with three replications. African and French marigold (*Tagetes erecta* L and *T. Patula* L) respectively cvs., Pusa Narangi Gaiinda (which was developed at IARI, New Delhi) and Delhi local mix respectively were sown at monthly intervals starting from June to November 1998 (20th of every month) and were transplanted on 20th July, 20th August, 20th Sept, 24th October, 26th November and on 20th January, 1999 respectively. Due to heavy rains during June and July, we lost data on plants in control treatment and as a consequence the data of the remaining treatments was subjected to statistical analysis following Panse and Sukhatme, (1985) and the mean data of 4 dates of sowing treatments were presented in Tables 1 & 2.

In the experiment, four seed treatments given before sowing were (T<sub>1</sub>) soaking of marigold seeds in distilled water for 24 hours; (T<sub>2</sub>) seed soaking in 0.1 m M KNO<sub>3</sub> (prepared by dissolving 10 mg of Potassium nitrate in 100 ml of distilled water) for 24 hrs and (T<sub>3</sub>) seed soaking in 0.1 m M Na<sub>2</sub>HPO<sub>4</sub> (prepared by dissolving Disodium Hydrogen Phosphate (Na<sub>2</sub>HPO<sub>4</sub>), 0.0142g in 100 ml distilled water) for 24 hrs. and (T<sub>4</sub>) dry seed sowing (control). The

treated seeds were sown in the nursery as per the seed treatment.

Seedlings were transplanted in experimental field at a spacing of 45cm x 30 cm (plot size 3m x 2m) with recommended fertilizer dose (120 : 60 : 90 kg NPK ha<sup>-1</sup>) as irrigated crop during 1998 - 99. Data was collected on germination %, speed of germination, field establishment, days to first flowering, 50% flowering, duration of flowering, flower diameter, flower yield ha<sup>-1</sup> and seed yield ha<sup>-1</sup>. The details of the procedures followed are given here under.

**Germination Test :** 200 Nos. (50 each in petriplate) of seeds per replication (three replications were maintained) were kept for germination (ISTA, 1985) at 25°C in BOD. At 6<sup>th</sup> and 9<sup>th</sup> day, observations were recorded on % of germination under laboratory conditions.

**Seedling Emergence and Speed of Germination (Seed Vigour):** Three replicates of hundred seeds of both the varieties as per the treatments were hand - planted in soil in a completely randomized design. Any seedling, which has an intact plumule above the soil surface was considered to have emerged. The emergence of such seedlings in two cultivars was recorded from day one to ninth day. This germination count on ninth day was taken as final count for germination under open field conditions. Observations on the seedling emergence was recorded up to the ninth day and this data was used for calculation of speed of germination (seed vigour) as suggested by Maguire (1962).

Speed of Germination (Seed Vigour) =  $\Sigma \frac{n(d_1 - d_2)}{t}$   
Where, n = number of seedlings emerged after days d<sub>1</sub> - d<sub>2</sub>, t = time in days

**Field Establishment :** Vigorously growing seedlings @ forty four seedlings per plot were transplanted in the field. Number of plants

survived per plot was recorded after 10<sup>th</sup> day of transplanting for calculating the per cent of field establishment.

$$\text{Field establishment \%} = \frac{\text{No. of Plants per plot survived after day 10} \times 100}{\text{Total No. of plants per plot transplanted (44)}}$$

The number of days taken transplanting to first flower opening in each plot was noted as days to first flowering. The number of days taken from seedling transplanting for half of the plant population showing opened flowers in each plot was noted as 50% flowering. Flower diameter was measured at fully opened stage with the help of scale by taking observations from North - South and East - West directions.

**Flower yield per hectare (tonnes) :** It was calculated by multiplying the percent field establishment with flower yield per plant with plant population.

$$\text{Flower Yield ha}^{-1} \text{ (tonnes)} = \frac{\text{Field establishment \%}}{100} \times \frac{\text{Flower yield in kg plant}^{-1} \times \text{Total area}}{100 \times \text{Area occupied by single plant}}$$

$$\text{Seed yield ha}^{-1} \text{ (kg)} = \frac{\text{Field establishment \%}}{100} \times \frac{\text{Seed yield plant}^{-1} \times \text{Total area}}{100 \times \text{Area occupied by single plant}}$$

**Storing Hydrated Seed :** A Study was conducted to determine the duration of benefits from primed marigold seed. The seeds were soaked for 4 hours in distilled water, dried in shade over silicagel in a desiccator and stored for six months. The seeds were tested for germination at bi-monthly interval and the stored seeds were hydrated for 24 hrs, before testing for germination. Both stored and rehydrated seeds were tested for standard germination.

## RESULTS AND DISCUSSION

Soaked seeds germinated sooner than dry seeds in both the cultivars under laboratory as well as open field conditions. Seeds sown dry had 73%±1 and 26% germination under lab and soil conditions respectively (T<sub>4</sub>) where as other three treatments had significantly higher germination (Table 1). Seeds soaked in distilled water for 24 hrs (T<sub>1</sub>), seeds soaked in 0.1M KNO<sub>3</sub> for 24 hrs (T<sub>2</sub>) and seeds soaked in 0.1 M MnNa<sub>2</sub>HPO<sub>4</sub> for 24 hrs (T<sub>3</sub>) were visibly enlarged with most of the testa ruptured. French Marigold had higher % germination over African marigold under both lab as well as soil conditions (Table 1). Seeds of T<sub>1</sub> treatment had higher germination of 12.66% in African Marigold and 9.67% in French Marigold over the control treatment (72.5% and 74.75%) under laboratory conditions, where as in field conditions African Marigold showed increased germination of 146% in T<sub>1</sub> treatment, 130% in T<sub>2</sub> and 98% in T<sub>3</sub> treatment over the control (26.0%) treatment. In case of French Marigold, a germination hike of 197% was recorded in T<sub>1</sub> treatment, 138.8% in T<sub>2</sub> treatment and 125.24% in T<sub>3</sub> treatment over the control treatment T<sub>4</sub> where it was 25.75% only.

In all the treatments (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>) seeds germinated 2-3 days earlier in case of African Marigold, where as 1-2 days in French marigold over the dry seed sowing (T<sub>4</sub>) (Fig :1). With regard to the speed of germination, all the treatments had more than 70% increase over the control in both the species. Seed-soaking in distilled water treatment had increased the vigour to 77% in African Marigold and 79.3% in French Marigold over the control (Table 1).

In all the four planting dates, the seed treatments reduced the days to first flowering and 50% flowering from the transplanting

Table 1: Effect of Seed Treatments on Seedling Characters in African Marigold (A.M) and French Marigold (FM) under different Sowing Dates

Character Treatment	Germination (%) (Lab Conditions)		Speed of Germination (Seed Vigour)		Field Establishment (%)	
	AM	FM	AM	FM	AM	FM
T <sub>1</sub>	83.00	82.75	16.64 (61.5%)	20.79 (76.5%)	93.83	98.97
T <sub>2</sub>	81.25	80.00	15.71 (57.0%)	16.93 (61.5%)	89.56	93.92
T <sub>3</sub>	79.00	79.00	14.35 (47.0%)	15.75 (58%)	84.69	91.21
T <sub>4</sub>	72.50	74.75	3.84 (26.0%)	4.31 (25.75%)	88.17	97.20
CD ± (P=0.05)	0.50	0.74	0.32	0.08	0.55	0.89

Note : Values in parenthesis indicate the germination percentage under Soil (open field) Conditions.

Table 2 : Effect of Seed Treatments on Flowering and Yield in African Marigold (AM) and French Marigold (FM) at different Planting Dates.

Character Treatment	From Transplanting (in days)				Flower Diameter (Cm)		Flower Yield (Tonnes / ha)		Seed Yield (Kg ha <sup>-1</sup> )	
	First Flowering		50% Flowering		AM	FM	AM	FM	AM	FM
T <sub>1</sub>	70.25	61.83	92.17	76.08	6.74	3.68	15.3	11.0	364.8	425.3
T <sub>2</sub>	71.67	65.08	92.83	79.00	5.80	3.61	11.6	9.1	294.7	329.5
T <sub>3</sub>	74.67	66.17	93.18	79.33	5.94	3.62	8.9	8.0	226.4	272.5
T <sub>4</sub>	77.25	69.75	98.50	79.42	6.34	3.63	14.3	10.6	326.1	394.3
CD ± (P=0.05)	0.32	0.39	0.39	0.48	0.54	0.02	0.75	0.28	13.33	9.50

## Seed Treatments

- T<sub>1</sub> = Soaking seeds in distilled water for 24 hours  
 T<sub>2</sub> = Soaking seeds in 0.1 m M KNO<sub>3</sub> for 24 hours  
 T<sub>3</sub> = Soaking seeds in 0.1 m M Na<sub>2</sub>HPO<sub>4</sub> for 24 hours  
 T<sub>4</sub> = Dry seed (Control)

Table 3: Effect of Storage and Hydration (H) on per cent germination of Hydrated Dried (H-d0) Seeds of French Marigold and African Marigold

Seed Storage	African Marigold		French Marigold	
	AM	FM	AM	FM
Octo'98 (Initial)	72.0	86.0	72.0	76.0
Dec' 98	72.0	78.0	72.0	75.0
Feb' 98	70.0	74.0	72.0	72.0
April' 99	63.0	66.6	58.0	59.0
CD ± (P=0.05)	1.22	0.86	0.197	0.139

compared to control in both the Marigolds. French Marigold flowered earlier than African Marigold in all the treatments (Table 2). Soaking seeds in distilled water for 24hrs resulted in early flowering of 7 days in both the Marigolds over the first flowering of untreated check (77 and 69 days respectively). Similarly 50% flowering was also earlier by 5 days in African and 3 days in French Marigolds over the check (98.5 and 79.42 days respectively).

Flower diameter was not affected significantly by the seed treatment except soaking seed in distilled water for 24 hrs treatment (T<sub>1</sub>). African Marigold had higher flower diameter over French Marigold in all the treatments (Table 2). Flower diameter in other treatments varied from 5.80 cm to 5.94 cm in African Marigold and 3.62 cm to 3.61 cm in French Marigold which were at par with that of untreated check (6.34 cm and 3.63 cm in African and French Marigold respectively).

Both the Marigold species showed reduction in germination over storage and followed the same trend. Re-hydration for 24 hrs before keeping for germination resulted in higher germination in both the species. Potential capacity for rapid germination was also followed in a decreasing trend in both the Marigold species (Table 3).

The delay in germination and late flowering of dry sown seeds might have resulted from slower reactivation of essential enzymes. Heydecker and Coolbear (1977) reported that hydration of seeds during priming enhanced the embryo's ability to synthesise proteins and RNA resulting in earlier germination even under unfavourable environments. Deterioration of seed is manifested in the reduction of germination as well as vigour. Vigour is an important component of seed quality as it determines the planting value of a seed lot.

However, in the absence of any standard recommended test, vigour is determined by several attributes such as seedling growth, susceptibility to accelerated ageing and other biochemical and physiological measures (Abdul - Baki and Anderson, 1972 and Roberts, 1983). Since transplanting is practiced in marigold, seedling vigour is an important character for ensuring satisfactory establishment in the field. Hydration treatments, in water, osmoticum or salt solution with or without dehydration have been reported to be effective to varying extents in a number of field crops and vegetables (Heydecker and Coolbar, 1977, Nagar *et al.* 1998).

Information on the efficacy of hydration treatments in flower seed is scanty (Paramesh *et al.* 1994). In the present study, significant enhancement in speed of germination, final % germination and vigour were seen with simple hydration for 24 hrs or with two cycles of hydration.

Seed treatments did not significantly affect the field establishment of Marigold except in T<sub>1</sub> treatment (Table 1). The field establishment percentage in other treatments varied from 84.69% - 89.56% which were at par with that of control (88.17%) in African Marigold, where as in French Marigold T<sub>2</sub> and T<sub>3</sub> treatments had 93.92% and 91.2% which is significantly lower than the control treatment (97.20%).

Among all the treatments, French Marigold resulted in higher field establishment per cent over African Marigold, which might be due to the favourable microclimate created by its bushy habit more number of leaves which are linear are lanceolate type with short internodes.

Flower and seed yield attributes in both the Marigolds were found to be greatly influenced by the seed treatments (Table 2). Among the different seed treatments (Table 2) T<sub>1</sub> resulted in higher flower yield (15.3 t ha<sup>-1</sup>) in African

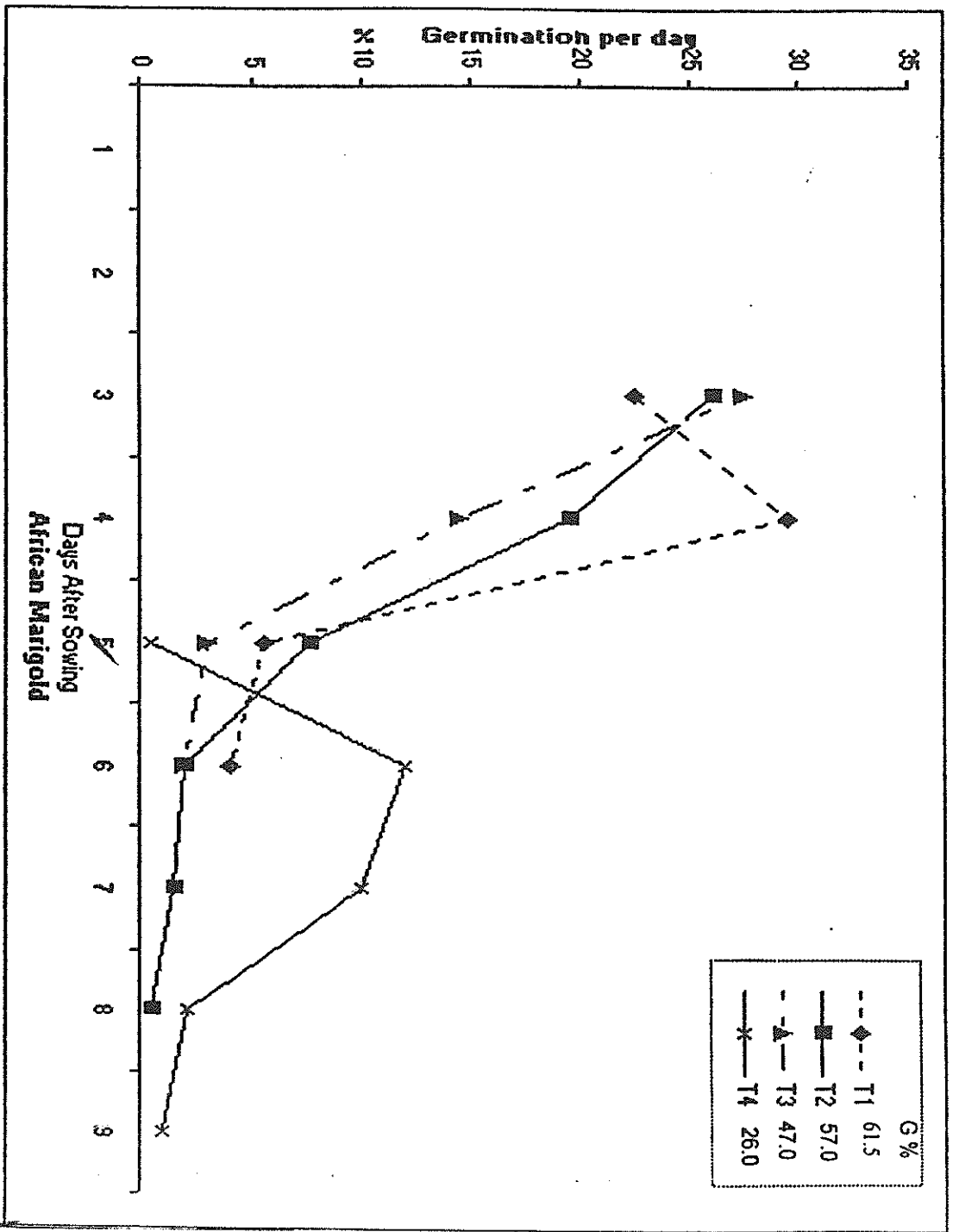


Fig. 1 Per cent Germination per day of African Marigold and French Marigold

35

G%

---◆--- T1 61.5

---■--- T2 57.0

---▲--- T3 47.0

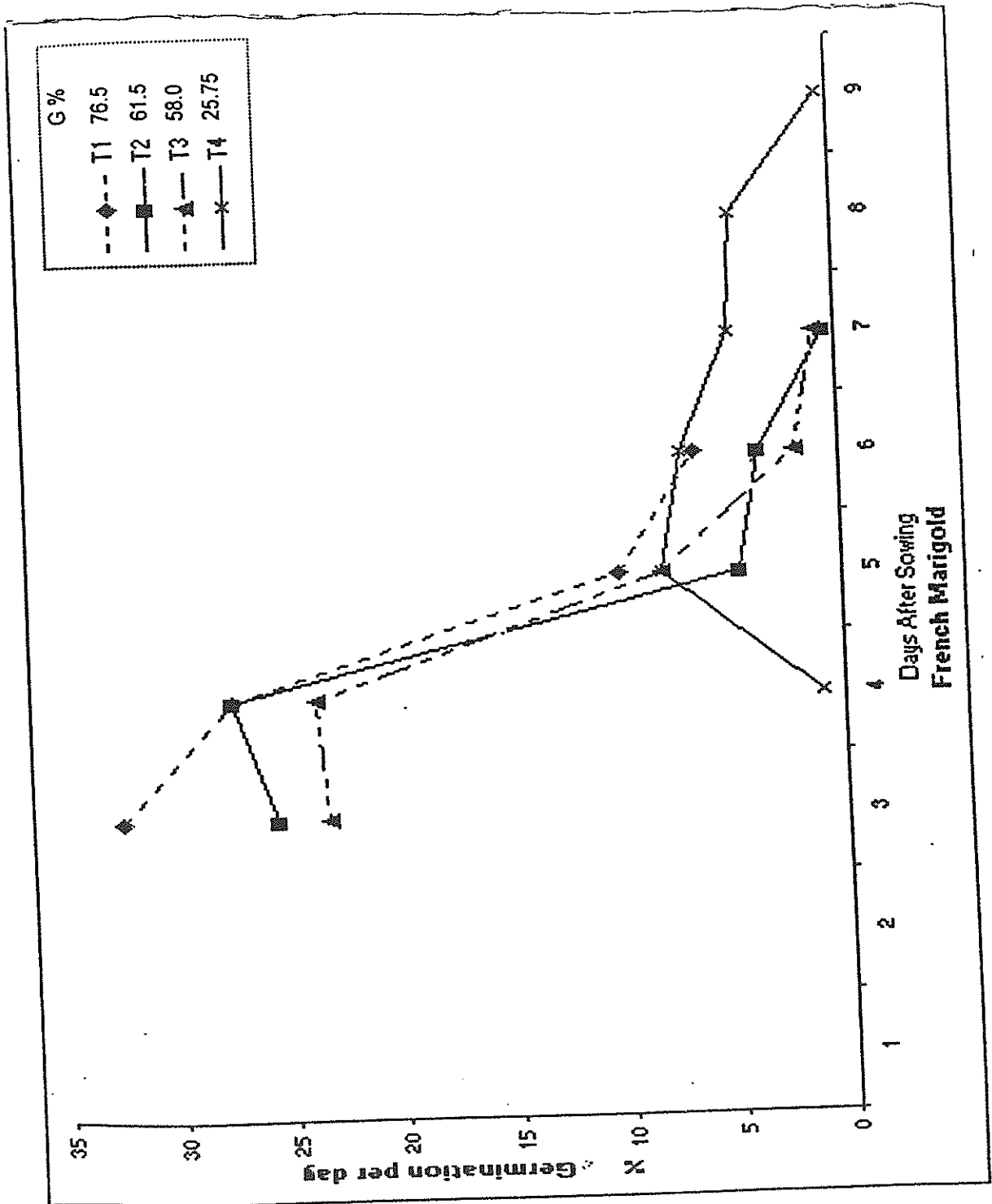
---x--- T4 26.0

--- T1 76.5



Jay. M. S. S. ng  
African Marigold

Fig. 1 Per cent Germination per day of African Marigold and French Marigold





Marigold and (11t ha<sup>-1</sup>) in French Marigold compared to the control. ( 14.3 t ha<sup>-1</sup> in African and 10.6 t ha<sup>-1</sup> French Marigolds). Similar results were obtained with regard to seed yield with T<sub>1</sub> treatment in African Marigold (364.8 kg ha<sup>-1</sup>) over control (326.1 kg ha<sup>-1</sup>) and in French Marigold (425.3 Kg ha<sup>-1</sup>) compared to control (394.3 kg ha<sup>-1</sup>).

African Marigold recorded higher fresh yield ha<sup>-1</sup> than French Marigold whereas French Marigold recorded higher seed yield ha<sup>-1</sup> than African Marigold. Significant improvement in yield and yield attributes was observed with seed treatment (Table 1 & 2). The treatment soaking seeds in distilled water for 24 hrs showed superiority in increasing field establishment, fresh flower weight and flower yield plant<sup>-1</sup>.

In conclusion the results of the study indicated the superior performance of T<sub>1</sub> treatment (seeds soaked in distilled water for 24 hrs) over the control. All the treatments, however, performed well with seeds soaked in 0.1m M KNO<sub>3</sub> and 0.1m M Na<sub>2</sub>HPO<sub>4</sub> for 24 hrs in respect of germination and flowering. All the seed treatments promoted 2-3 days earlier germination than the control in both the Marigold species. Storage of dried and soaked seeds resulted in faster loss of seed viability and potential capacity for rapid germination.

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