

Phenotypic of Varieties Chrysanthemum in Lowland Area Cultivation

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Abstract. The Chrysanthemum is a subtropical ornamental plant that is usually grown in highland areas. Indonesia is a tropical area consisting of highland and lowland areas. Chrysanthemum was growing well in highland areas in Indonesia but was not cultivated yet in lowland areas. The research objectives were to evaluate the phenotype of Chrysanthemum varieties in vegetative stadia and assess the survival abilities of the Chrysanthemum varieties in the low area. Four varieties were evaluated and assessed to be cultivated in lowland areas (187.6 meters above sea level). They were Jayani, Sabiya, Swarna Kencana, and Trissa varieties. The experimental design was using Randomized Complete Block Design (RCBD), which consisted of 4 replications, with each replication consisting of 4 varieties, and each variety consisting of 20 plants. The parameters observed were the plant height (cm), number of leaves, leaves width (cm), leaves length (cm), total number of nodes, and internode length (cm). All varieties were adapted and grew well in the lowland area. There were many differences in morphological and quantitative characters in vegetative stadia. Chrysanthemum cv. Swarna Kencana showed the highest plant height in a low area. These varieties also showed the highest survival ability in the lowland area. Swarna Kencana was the Yellow Orange group as consumer preference. It was suggested that chrysanthemums be adapted in the lowland area. The implication of the research was Swarna Kencana could be a genetic resource and germplasm for breeding materials.

Keywords: Chrysanthemum, Lowland area, Morphology character, Phenotype.

1 Introduction

The chrysanthemum is an important cut flower in the floriculture industry. It was propagated vegetatively, belonging to the Asteraceae family [1]. Chrysanthemums consist of two types of florets, ray florets, and disk florets, while the small yellow florets at the center are disk florets. [2]. Chrysanthemum breeding has resulted in many cultivars, produced as cutting, potted types, and garden plants in the world for several years. The

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breeding focused to develop new varieties with fresh appearance, improved stress resistance, and superior quality characteristics [3]. *Chrysanthemum morifolium* and *Chrysanthemum indicum* flower contain highly nutritive and phytochemical components for medicinal tea and cosmetic purposes. anti-bacterial, anti-oxidant, anti-inflammatory, and anti-arthritic properties. *Chrysanthemum* leaves and stems contain major bioactive components like those of the flower including flavonoids, terpenoids, volatile oils, polysaccharides, and Phenols. Flavonoids from *chrysanthemum* exhibited anti-tumor effects on MKN45 cells, showing the plant's potential as an anti-tumor therapy for gastric cancer [4].

Chrysanthemums originated in subtropical areas, most cultivated in the highland area and rarely cultivated in lowland areas. Some subtropical *chrysanthemum* varieties were introduced and cultivated in tropical areas such as Indonesia. The *chrysanthemums* adapted and grew well in highland areas. There were some opportunities and limitations to cultivating *chrysanthemums* in the highland area. Some opportunities for cultivation in highlands were (1) climate suitability. (2) flower quality. (3) resistance to pests and diseases. The opportunity was also optimum for productivity and quality as standard requirements in floriculture industries. However, cultivation in lowlands has high rainfall and temperatures, so *chrysanthemums* are susceptible to aphids [5]. *Macrosiphoniella sanborni* (Gillette), Hemiptera Aphididae is the main pest responsible for the damage to *chrysanthemums*. These insect pests are the limiting factors for higher production as well as good quality flowers [6]. Aphids were sap-sucking insects that affect plant species and caused a wide range of damage, including weakening and yellowing, sprout deformation, honeydew secretion, consequent fungal development, and virus transmission that causes diseases [7]. Breeding of *Chrysanthemum* has also focused on stress resistance, and tolerance to cold and drought, such as *C. dichrum*, *Chrysanthemum indicum* "Nankingense," are highly tolerant to drought conditions [8] While the limitation cultivated in the highland areas were limited areas, and farmers because farmers close to the area can cultivate, market segments, growers, transportation, and quality during transportation. It was influenced by vase life and flower freshness decreased. Based on the problems, it was necessary to cultivate *chrysanthemums* in lowland areas. Cultivation in lowland areas became an alternative solution to extend *chrysanthemum* production, improving the color quality by creating novelty and new varieties adapted to low areas. It also extended the market segment around the cultivation area and market center, keeping fresh flowers for easy transportation in closer cultivation areas. Finally, the new *chrysanthemum* varieties adapted to lowland areas are useful as new germplasm for breeding materials.

2 Material dan method

The research was conducted in Screenhouse KST Soekarno Cibinong, Bogor West Java. As selected parent's breeding materials, four varieties were Jayani, Sabiya, Swarna Kencana, and Trissa. All *chrysanthemum* varieties were highland area *chrysanthemums*, cultivated for selected and adapted for lowland area cultivation (table 1).





The phenotypic of *Chrysanthemum* varieties was evaluated in vegetative stadia and assessed the survival abilities of the *Chrysanthemum* varieties in the lowland area. The experimental design was using Randomized Complete Block Design (RCBD), which consisted of 4 replications, with each replication consisting of 4 varieties, and each variety consisting of 20 plants. The materials used were *chrysanthemum* cuttings from 4 varieties of *chrysanthemums*, both standard and spray types (Swarna Kencana, Jayani, Sabiya, and Trissa varieties) (table 1). The parameters observed were a) plant height (cm), b) the

number of leaves, c) leaves width (cm), d) leaves length (cm), e) the total number of nodes, and f) internodes length (cm). All parameters were measured based on the Chrysanthemum Standard Operational Procedure (SOP). Plant height is measured from the media surface where it grows to the tip of the growing point, using a ruler as a measuring tool. The number of leaves was calculated by the number of leaves on each plant, and the length of the leaves was measured from the petiole to the tip of the leaf on the widest leaf. Leaf width is measured at the center of the leaf from its widest part. The number of nodes was measured from the bottom to the tip of the plant. Internode length is measured between node segments, from one node segment to another in one plant.

2.1 Land preparation

Land processing was carried out two weeks before the planting. Watering is done before the soil is processed until it is certain that it is saturated with water. Land preparation is done manually with a hoe, by turning the soil over until it is loose and even. The next stage is the application of *Dolomite calcium* to increase soil pH. They are manure and urea fertilizer. The dose of manure given is 5 kg per plantation row, 25 kg *Dolomite calcium* per 4 plantation rows, and 25 g/m² of urea, with a distance between rows of 50 cm. KCl 35 g/m² supplementary fertilizer was given one week after that. The supplementary fertilizers were Urea 1.5 g/m², KNO₃ 6 g/m² and 39 g/m² SP 36.

Table 1. Characteristic of Chrysanthemum varieties as selected breeding parents adapted low land area.

No.	Varieties	Type of flower	Color	Cultivation area	Main characters
1.	Jayani 	standard	White	High land area (700 – 1.200 MASL)	A big stem showed a strong stem for big flowers and a long vase life.
2.	Sabiya 	spray	Yellow group RHS color chart 5 A	High land area (700 – 1.200 MASL)	Flower shape: double, spray, yellow flower
3.	Trissa 	spray	Red purple group RHS 60 A	High land area (700 – 1.200 MASL)	Flower shape: double, spray, red flower
4.	Swarna Kencana 	spray	Yellow-orange groups 15 A	High land area (700 – 1.200 MASL)	Single flower shape

2.2 Chrysanthemum cultivation

Four varieties of chrysanthemums (Jayani, Sabiya, Trissa, and Swarna Kencana) were assessed based on type, color, and superior characters. Rooted chrysanthemum cuttings are planted in the planting hole, according to repetition and watering is carried out after that. The important thing in chrysanthemum cultivation was pinching in vegetative stadia. Pinching affected the plant growth and production of quality flowers in the field. Pinching carried out in chrysanthemums improved in number of flowers per plant, plot, and yield per hectare [9].

2.3 Selection of chrysanthemum cultivar adapted low land area as parent's breeding

The assessment and selection of Chrysanthemum-adapted low areas were carried out at 187.6 meters above sea level. Four varieties of Chrysanthemum were planted in KST Soekarno BRIN Cibinong (low land area), with temperatures about 27.1 -37. 2 °C and humidity about 40- 74%. Chrysanthemum selection is determined by observing the survival of plant growth in lowland areas in vegetative and generative stadia, and the blooming ability to produce flowers.

3 Results and discussion

Some limitations of Chrysanthemum cultivation were production, market segments, and cultivation just in highland areas, so it was necessary to create Chrysanthemum-adapted low areas. The price of developing Chrysanthemum in the lowlands became cheaper because transportation costs can be reduced. In previous research on broccoli, the development of broccoli in the lowlands could reduce transportation expenses [10].

The main difference between the cultivation environment in the highland compared to the lowland area was temperature, humidity, and light intensity. The average temperature was 32.41°C and the average humidity was 57.36 %. Light is an essential environmental factor that regulates plant growth and development. Plants capture light energy for photosynthesis as well as for light signaling in different regulatory processes [11]. The limitation of cultivation in the lowlands was high temperature above the optimal plant temperature, and it affected plant growth and yield [12]. The lowland adaptive plants were also important to overcome production constraints and resistance to pests and diseases that affect yields [13].

The percentage of survival chrysanthemums in lowland areas was more than 95% (Swarna Kencana, Jayani, Sabiya) and just about 5% did not survive for the Trissa variety. Most of the varieties were growing well in the lowland area. It indicated that most chrysanthemums adapt to lowland areas (table 2). Maintaining productivity from unfavorable environmental influences such as from highland to lowland areas, besides using superior varieties, also needs good cultivation techniques [14].

Table 2. Percentage of survival rate of Chrysanthemum varieties, 1 and 3 wap (weeks after planting).

Varieties	1 wap	3 wap
Swarna Kencana	100%	100%
Sabiya	100%	100%
Trissa	95%	95%

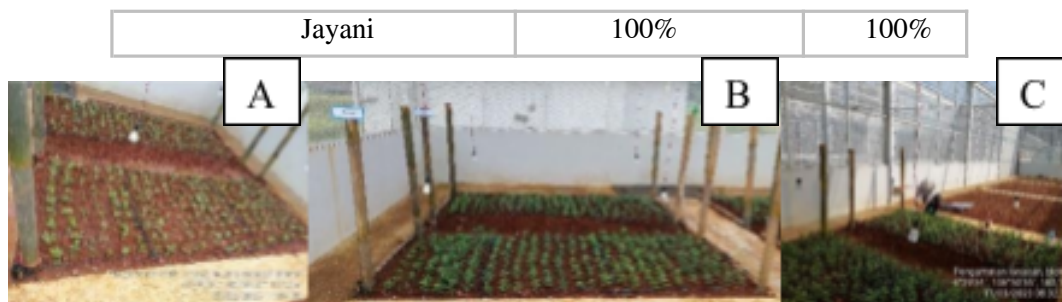


Fig. 1. The survival rate of Chrysanthemum in lowland areas 1 week after planting (A) and 3 weeks after planting (B & C).

Response of varieties grew well, and most rooting plants survived in the first week after cultivation. In the third week after planting, there was variation in growth response among the varieties, especially for plant height (figure 1). Swarna Kencana was the highest plant. However, it was blooming lately, about 4 months after planting. Swarna Kencana is genetically blooming at 48- 50 days after planting. It means that the adaptation ability of the chrysanthemum was influenced by genotype and environment. Like previous research, Genotype x environment interaction (G x E) is important to assist in the identification process of superior genotypes. It also shows the stability of an object’s genotypes when grown in different environments [15]. The superior genotype was adapted in a low land area in the Chrysanthemum case.

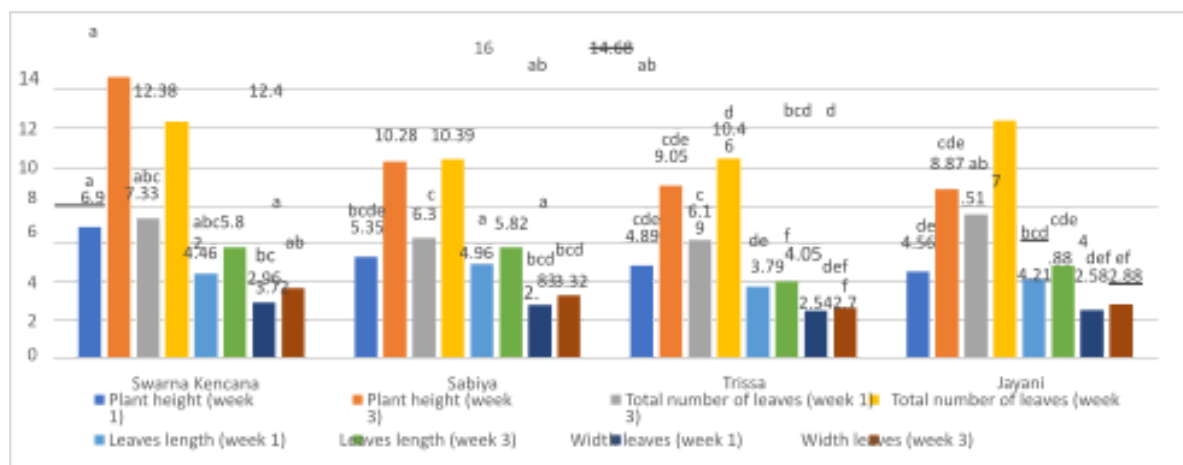


Fig. 2. Variation response in vegetative parameters from chrysanthemum varieties 1 and 3 weeks after planting.

Swarna Kencana was the highest for plant height parameter, followed by Sabiya, Trissa, and Jayani. There were no significant differences in the total number of leaves in all varieties (figure 2). Most variations were influenced by genetic characteristics and environment. Swarna Kencana and Sabiya varieties were more adapted to lowland areas than others.

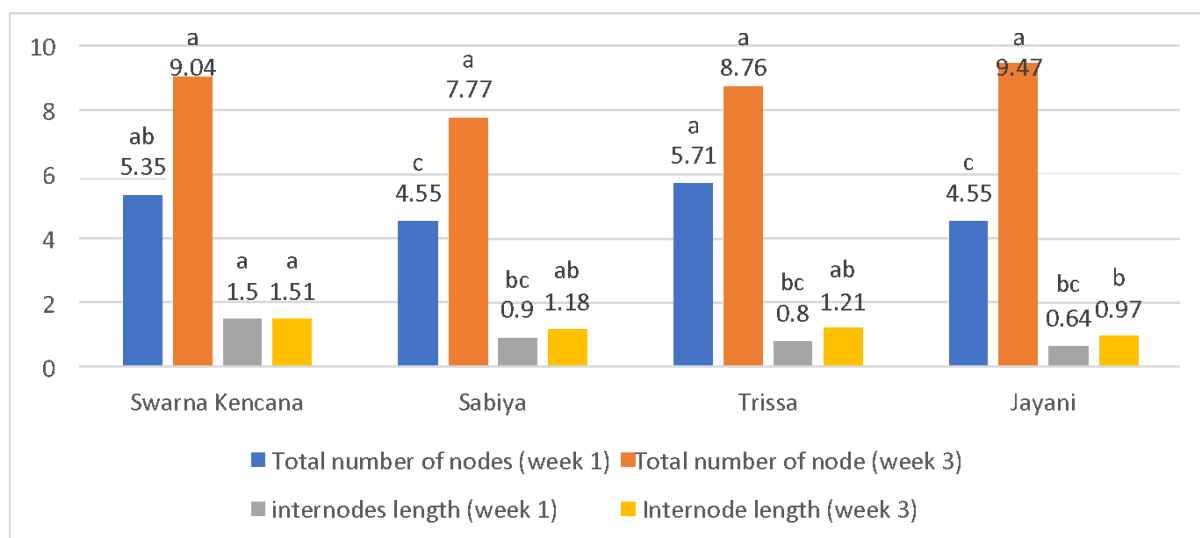


Fig. 3. Total number of nodes and internodes length in some chrysanthemum varieties 1 and 3 weeks after planting.

The total number of nodes was not significantly different in all varieties, even though the plants' heights were different. The highest internode length was obtained Swarna Kencana variety. Swarna Kencana was significantly different from Jayani for internode length. Usually, the environment influences quality and plant performance. Chrysanthemums in highland areas had different performance than those in lowland areas. The differences were also about the size of the flower and leaves (figure 4). The highland chrysanthemum size is bigger than the lowland area. It was also for color, highland chrysanthemums were brighter than lowland areas [10]. Anthocyanins were a key factor in ornamental plant color. Petal colors were formed by the accumulation of a single pigment, or a combination of multiple pigments, such as anthocyanins, carotenoids, and chlorophylls, or the absence of these pigments [16].

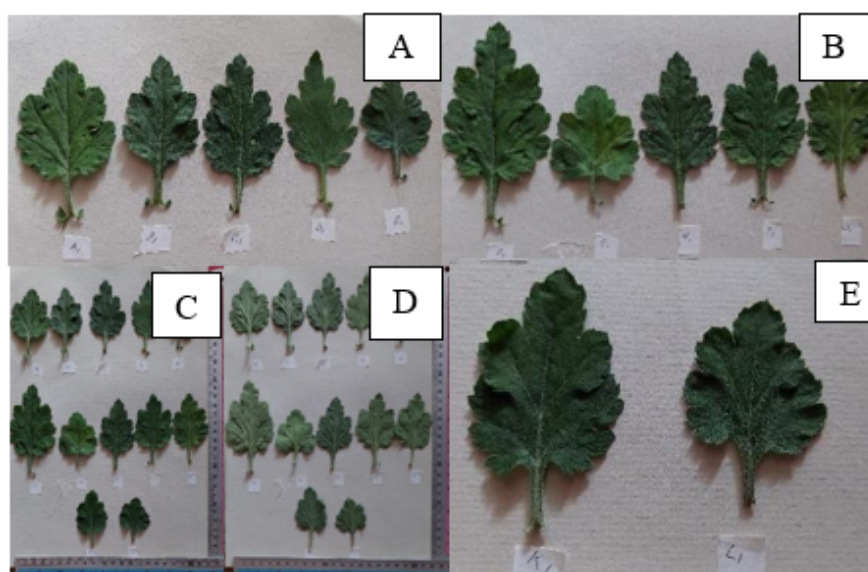


Fig. 4. Variation of leaves shape and size in chrysanthemums 3 weeks after planting. Swarna Kencana (A1) comparing other varieties (A, B, C & D, E).

There was variation in morphological leaves in some varieties of chrysanthemum cultivated in lowland areas. The variations were the shape and size of the leaves. The biggest size was obtained by Swarna Kencana and Sabiya varieties. The leaf length was

about 5.8 cm for both Swarna Kencana and Sabiya varieties (figure 4). The intensity of light greatly influences plant growth in the lowlands. The lowlands generally have quite high temperatures compared to the highlands. The external quality of cut chrysanthemums was usually evaluated in terms of stem and leaf morphology and flower characteristics. Each external quality aspect is influenced by several growing conditions that interact with each other [17].

The intensity of light and manipulated microclimate around the plants also influenced the morphology of leaves. [18]. Another manipulation of the microclimate was used by shading. Shading was used to reduce the intensity of light received by plants and the air temperature around the plants [19]. The qualitative character of chrysanthemum, such as flower color was determined based on flavonoids, carotenoids, and betalains. Anthocyanins are a group of secondary metabolites belonging to the flavonoid family. Flavonoids were demonstrated in a wide range of orange to red and purple to blue flowers [20].

4 Conclusions

Most of the chrysanthemum varieties survived and adapted in lowland areas. The phenotypic variations in vegetative stadia were obtained. They were the size and shape of the leaves, and all parameters were observed, except the total number of nodes. Swarna Kencana was recommended for cultivation in lowland areas, with the best performance among other varieties. Swarna Kencana could be a new genetic resource and germplasm for breeding materials, especially for lowland areas.

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