MORPHOLOGICAL ASPECTS FOR SELECTING NEW BEDDING PLANTS

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Abstract

Morphological properties are the first factors considered when choosing new ornamental plants. For bedding plants thick foliage and rich in blooming are traditionally appreciated. However, plants with modest growth habit may form a very decorative group if planted in great numbers. Therefore, to determine the suitability of a species for bedding purposes, not only single plant should be evaluated. Data collected during several years from the experimental collection of many ornamental bedding plants form the basis of this research. All species were planted in groups, with minimum 30 plants in each. The evaluations of decorative properties of species were analysed per group. In addition to height, number and diameter of flowers, thickness of a plant group were considered as an important property. Thickness was characterized by the vertical distribution of photosynthetically active radiation (PAR) in a plant group. New aspects to be followed in choosing species suitable for bedding plants and some methods to be used in comparing new bedding plants are discussed.

1. Introduction

The breeders of new ornamentals often face the question if the new product corresponds to consumer requirements. To bring a new floricultural crop to the market, thorough research and breeding work is needed. By the time the results are available the trend can be over and the crop in the phase of decline in its life cycle (Vonk Noordegraaf, 1998). Breeders are always facing the difficulty of anticipating evolution trends and their translation into breeding goals (Cadic and Widehem, 2001).

To adjust with new trends and demands beside entirely new ornamental plants new floricultural products of already known species have reached the market. For example many types of ornamental plants, which were used for a long time as garden and balcony plants, have found new uses as hanging baskets, potted and container plants (Von Hentig, 1995). For these purposes the morphological characters are the ones that determine the plant’s suitability for one or other uses. The breeding companies continue to offer new varieties for bedding purposes as well. However in breeding new bedding plants the producers and consumers needs must be considered. The interests of young plant producers, wholesalers and retailers are directed to the realization of single plants with attractive appearance and good transportation endurance. Landscape designers and gardeners, on the other hand, are interested in new bedding plants as a plant grown in group. It is ideal if new flower products correspond to the expectations of both sides. Unfortunately, many new varieties of such species as Lobelia, Nemesia, Nicotiana recommended for bedding purposes are not suitable, because their too compact plant habit characteristic to a young plant does not change when the plant grows. Such plants are suitable for a pot plant. As a bedding plant they are uneconomical, because the number of plants to be used on land unit is relatively large and their coverage for ground is uneven.
A very dense shrub decreases the plant's weather tolerance and its resistance to diseases. At the same time, some new varieties of *Zinnia* recommended for bedding purposes satisfy the needs of both—producers and designers. Originally compact plants soon forms good ground cover on the bed.

Many interesting species could be found from botanical gardens and plant collections, but these plants are often out of the breeders' interest. Their potential as a new crop is too small. An approach less focused to the single plant would help us better understand the potential of such plants. Some profiles have been developed to help people in making well-substantiated selections considering potential new pot, bedding and patio plants (Vonk Noordegraaf, 2000).

The present research concentrates on comparing the morphological properties of bedding plants from the viewpoint of landscape design. Therefore not a single plant but a group of the same plants has been studied. In visualizing the morphological properties some measuring methods characterizing mainly the properties of a plant group have been presented.

2. Materials and methods

Data collected during several years from the experimental collection of many herbaceous ornamental taxa form the basis of this research. In addition to well-known bedding plants, new or less known bedding plants for Estonia, such as *Anoda cristata*, *Alonsoa meridionalis*, *Cuphea procumbens*, *Dracocephalum moldavica*, *Tolpis barbata*, *Verbena canadensis*, etc were studied. All species were planted in groups of 30 or more, each plant being distant 25-30 cm from each other. The evaluations of decorative properties of species were analysed per group of plants grown on one square metre. Besides height, another important property evaluated was the thickness of a plant group, which was evaluated by decrease of photosynthetically active radiation (PAR) in plant group expressed as percentage of PAR above the plant group. Line-quantum-meter Li-191 was used for the measurements starting from the soil level upwards, with 20cm interval. In addition some plants from the middle of a group were removed and photographed.

A digital camera was used to make three different top view photos of every plant group during blooming. A 50x50cm frame was used to determine the area to be photographed. Within this frame the number of flowers or inflorescences was counted, and the diameter of flowers or inflorescences was measured with a ruler. Later the size of the coloured patch in the land unit was calculated by two methods: 1-on the basis of the number and diameter of flowers or inflorescence 2—using photo processing tools in the computer.

3. Results and discussion

3.1. Visualisation of plants properties

In scientific research graphical visualisation of plant characteristics and their changes is quite ordinary. Computer software enables us to follow plant growth and development on three-dimensional plant models representing either a single real plant, the average of several plants or a hypothetical plant (Room *et al.*, 1996). In horticultural research models are predominantly used to analyse horticultural treatments such as pruning and pinching, temperature and day length manipulation, application of chemicals, etc aimed at the optimisation of plant size, shape, quality and timing of flower production (Gary *et al.*, 1998; Prusinkiewicz, 1998). Plant models have been used, for example, in studying the influence of temperature on flowering rose shoot development (Pasia and Lieth, 1994, 1996) and flower bud elongation in Easter lily (Fisher *et al.*, 1996). Virtual plants have also been useful to phytopathologists in modelling plant disease dynamics (Wilson and Chakrabrty, 1998).
In addition to three-dimensional plant models, computer environment offers us also some less-complex methods. Among many possibilities, photo processing equipment enabling us to isolate single plants are proper for comparing their properties as new ornamentals. A picture complemented with a ruler makes it possible to determine plant sizes and their parts later. In this way this method produces material visualizing the morphological properties of different species (Fig.1). This is a simple and easy method to complement graphical representations recording changes in plant growth and development arising from the horticultural treatment used. A group constructed of single plants gives us also some idea of the bedding plant potential of studied plant or species (Fig.2).

3.2. Thickness of plant group

Depending on morphological properties, such as dimensions and shape of the plant canopy or single leaves, spreading of stems etc, the plants of different species form either thick or airy group. Landscape designers are interested in thickness due to its visual aspect, especially plant group texture, which, determined by the foliage, may be finer or coarser. On the other hand, thickness enables us to determine the light conditions of the herbage, which, on its turn, helps us to optimise the planting distances. For example, the experiments with *Phlox drummondii* showed, that too dense planting decrease blooming duration, the number of inflorescence and its diameter (Vabrit *et al.*, 2000). In controlled environment improved light conditions has increased the production of flowering stems in *Alstroemeria* cultivars (Bakken and Bævre, 1999). Insufficient light is also a reason of bottom leaves' to drop in aging plants of *Lavatera trimestris*, *Agastache foeniculum*, *Nicandra physaloides* etc.

Thickness of a single plant is characterized by its compactness index calculated using the height and diameter of the plant, as well as its leaf and stem area (Olsen and Andersen, 1995). Thickness of a plant group could be evaluated by the absorption of photosynthetically active radiation. Correlation analysis applied on measurements of plant groups from different species has shown that the amount of absorbed radiation does not depend on the height of herbage group, no matter what measurement level was used. Therefore, the deterioration of light conditions in vertical level are directly associated with the thickness of the herbage. Measurements of quantum flux density reaching the soil level showed that PAR absorption was less than 70-75% of total background radiation for species less suitable for bedding plants, such as *Clarkia bottae*, *Linum grandiflorum*, *Nigella damascena*, *Incarvillea sinensis*, etc. Higher absorption level differentiates the species and varieties studied mainly by airiness of their herbage. For example, the herbage of *Brachycome iberidifolia* absorbed 80 per cent and *Tagetes tenuifolia* 95 per cent of total background radiation. Still, this method is more suitable for comparing species with similar morphological properties, or for determining the effect of growing treatment within one species. In case of plants with large extending leaves in lower stem as *Nicotiana* the radiation measurements on soil level give us untrue information concerning general thickness of the plant group.

Measuring radiation absorbed in the herbage makes it possible to compare the species from the viewpoint of group homogeneity, as PAR measurements describe vertical distribution characteristics of leaf and stem areas mainly. In order to compare the species by distribution of radiation within the plant group, *Verbena canadensis* - a plant with habit most suitable for bedding – was used as a standard. *Verbena canadensis* forms even airy groundcover due to a high amount of small leaves and well-branched stems. In comparison, *Dracocephalum moldavica* had similar potential (Fig. 3). *Cuphea procumbens* with its semi-procumbent stems, as well as *Tolpis barbata* form thicker herbage near the ground and more airy in upper part. *Anoda cristata* with its broad shrub is characterized by even density, while *Alonsoa meridionalis* with its upright shrub form very sparse group when planted with 30 cm distance - the reason here is its smaller leaf area index.
The comparison in relative height units (PAR measurement height divided by the total height of the plant group) characterizes the density of different plant groups the best (Fig. 4). *Verbena canadensis*, *Dracocephalum moldavica* and *Anoda cristata* have similar vertical leaf-area distribution.

3.3. Visualisation of flowering

Although an environment having plants decreases the stress level in humans (Lewis, 1995; Lohr, 2000; Ulrich *et al.*, 1991), the large number of intensively coloured patches may be tiring due to physiological properties of the human eye. From a landscape point of view, highly intensive spot colours are therefore not always appreciated. The visual effect of a plant group depends on diameter of inflorescence or florets and their amount in land unit. The smaller the flower diameter is and the smaller the number of flowers, the weaker is the effect of flower colour. Therefore, the plant groups of species such as *Tolpis barbata*, *Cuphea procumbens*, *Verbena canadensis*, *Alonsoa meridionalis*, *Anoda cristata* are characterized by modest colouring due to smaller amount of flowers. In spite of that their appearance is delightful.

Usually, influence of different growth treatments on the quantity of flowers and inflorescence is determined by the flower number and diameter. Depending on the morphology of the flowers or inflorescences, the results obtained are not always accurate. For example, the number of flowers in the inflorescence may decrease due to environmental factors, but the diameter of the inflorescence does not necessarily reflect the change. In some species, such as *Impatiens walleriana*, *Lobularia maritima*, *Phlox drummondii*, *Sanvitalia procumbens* large number of flowers makes it difficult to determine their total number. Finally, the number of flowers or inflorescence and their diameter gives us the total area of flowers per surface unit or per plant, therefore also the information describing the size of a colour spot describes the flowering adequately. All the widespread photo-processing programs enable the user very precise selection by different coloured areas and to determine the share of such areas. Slight errors may arise from the inclination of flowers or inflorescences by the plane. It does not influence the results within one species as the differences in flower positioning characterize the whole plant group.

When traditional methods and photo processing was used in determining the flowering intensity of *Verbena canadensis*, the first gave us insignificance concerning the influence of temperature and precipitation on flowering, while the second method, based not on size of inflorescence but on the size of coloured spot, showed significant weather influence (Fig. 5).

In case of tall species and those of inflorescence types such as spike, raceme and panicle, evaluating flowering intensity by the coloured area is not applicable or, if applied, vertical plane should be used. Visual evaluation is highly suitable for the species, which form short plant groups.

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Figure 1. Visualisation of species to characterize their plant habit.

_Tolpis barbata_  
_Alonsoa meridionalis_  
_Verbena canadensis_

Figure 2. _Dracocephalum moldavica_ as bedding plant.
Figure 3. Vertical distribution of radiation in the plant group depending on species.

Figure 4. Vertical distribution of radiation in the plant group depending on species and as a function of relative height.
Figure 5. Effect of temperature and precipitation on flowering intensity of *Verbena canadensis* as measured by photo processing or traditional methods.